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VOL XXII No 11
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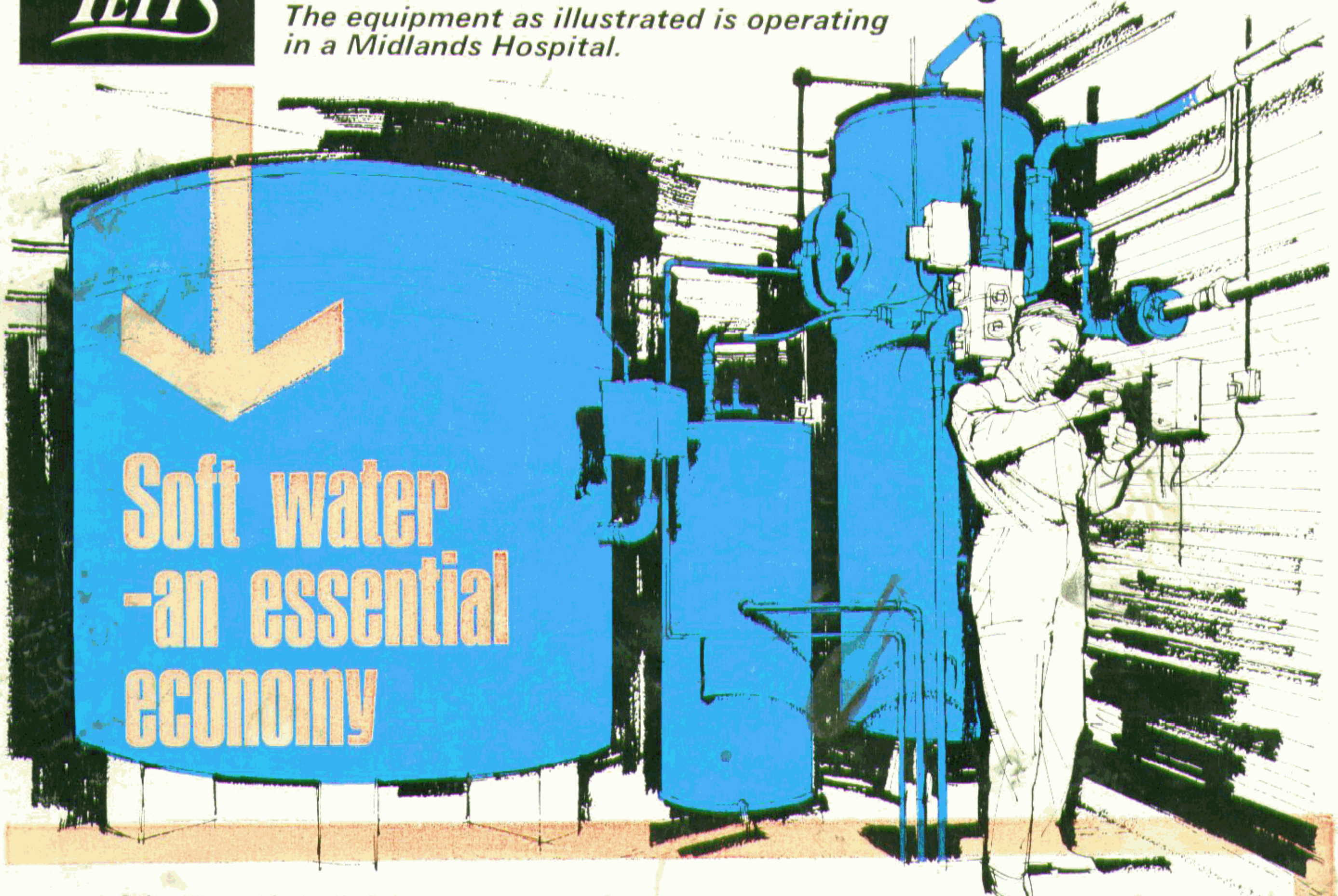

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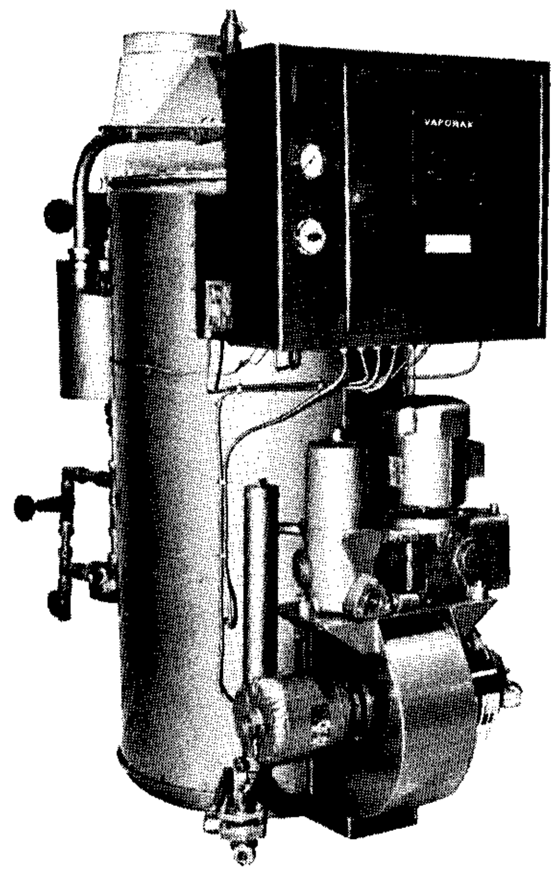

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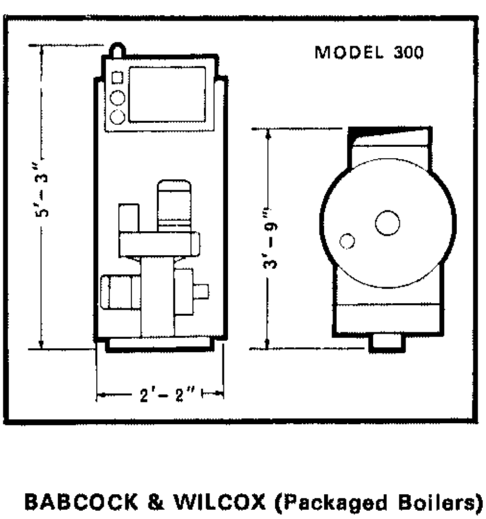

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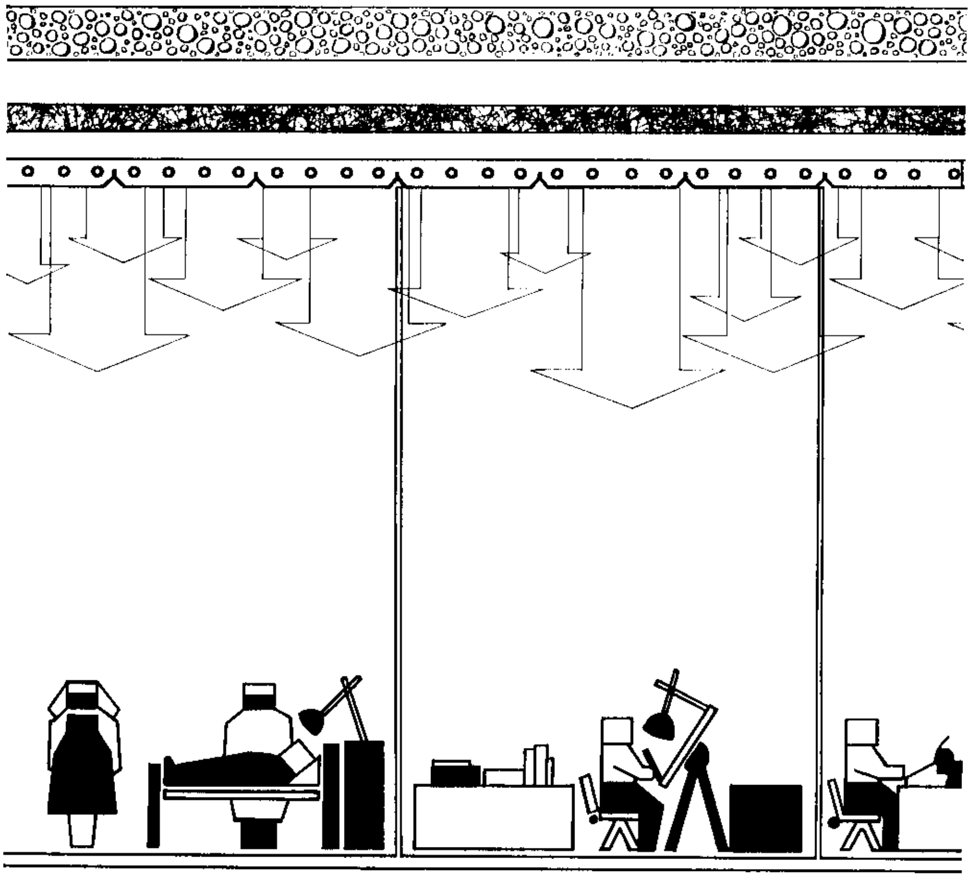

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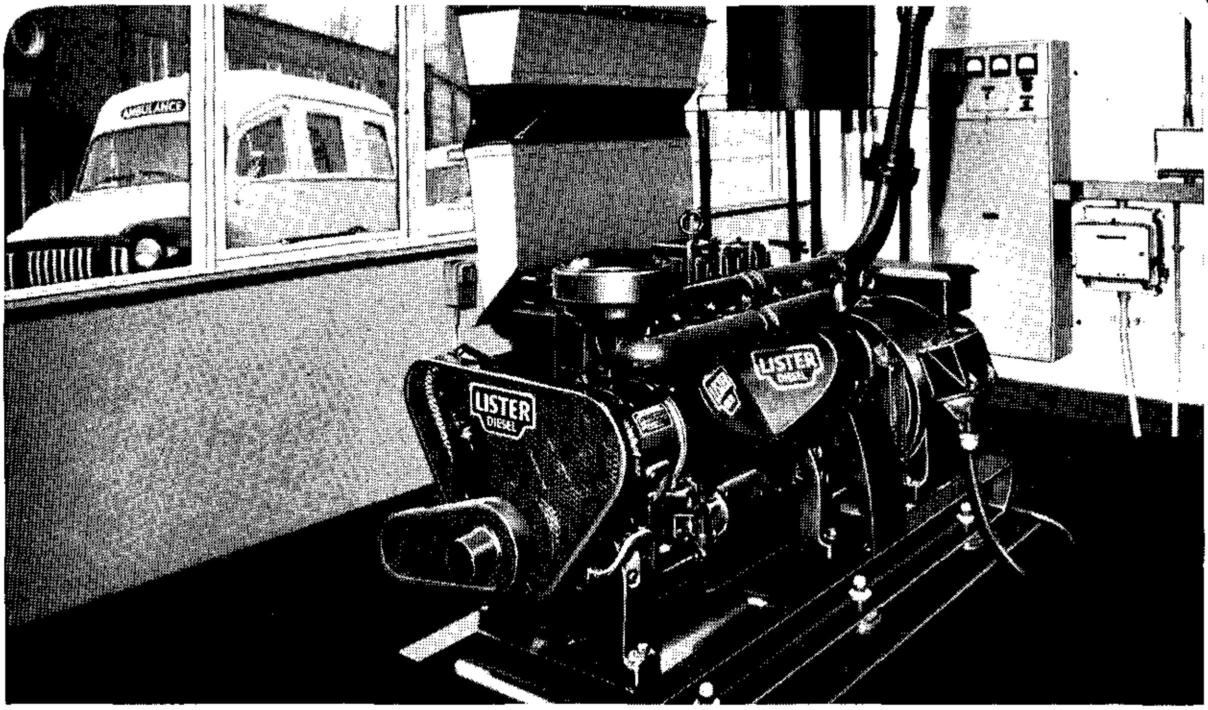

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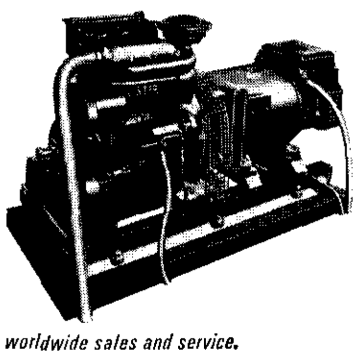

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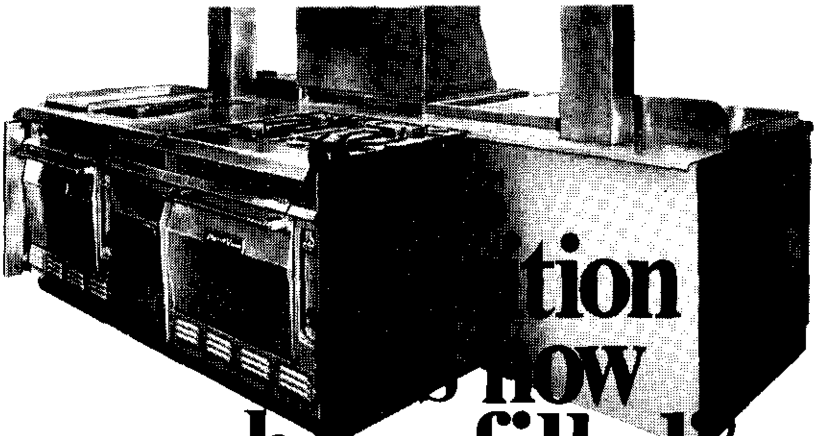

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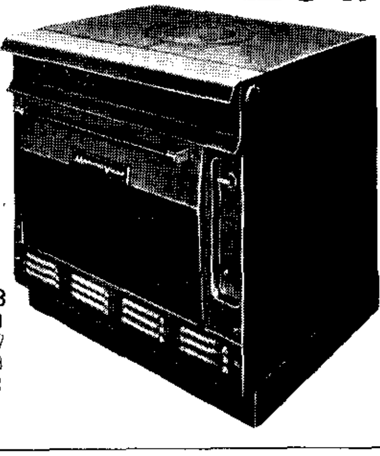

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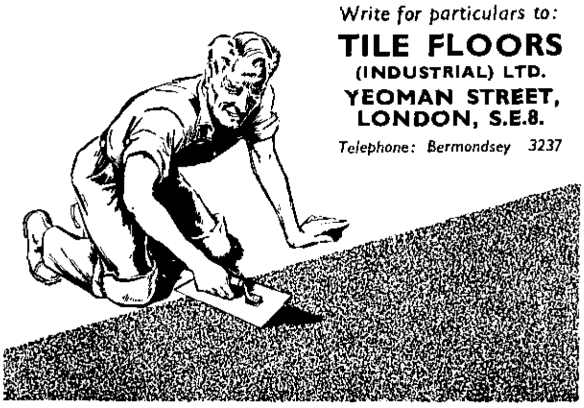

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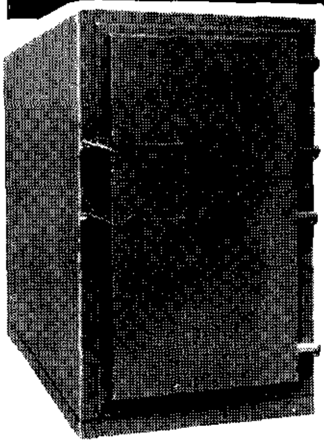

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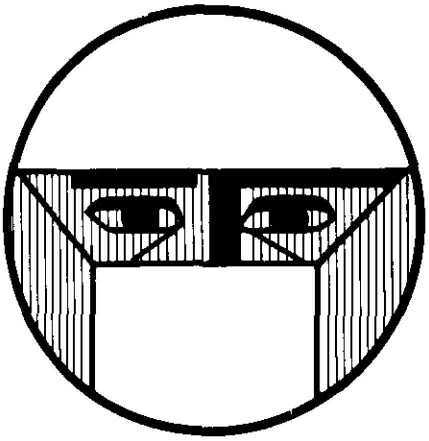

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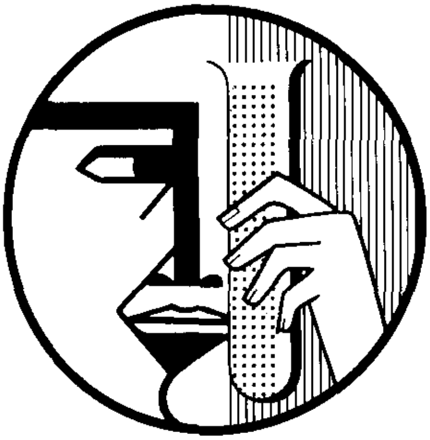

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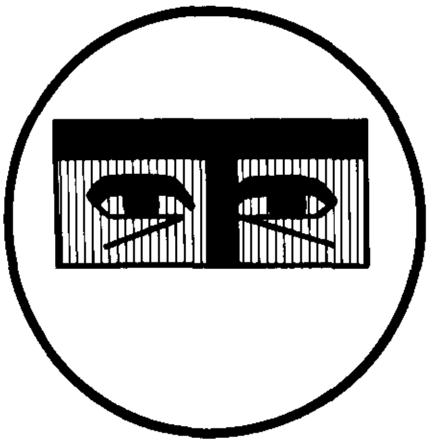

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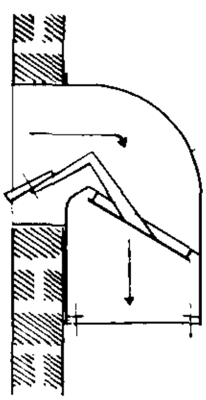

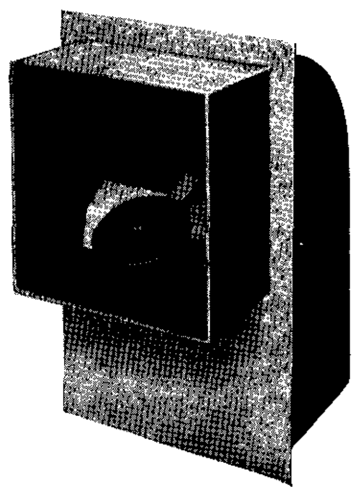

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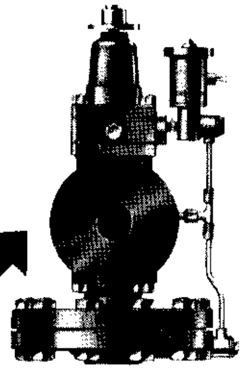

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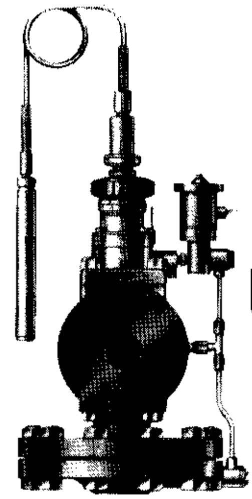

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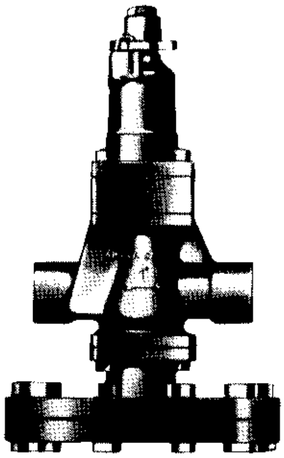

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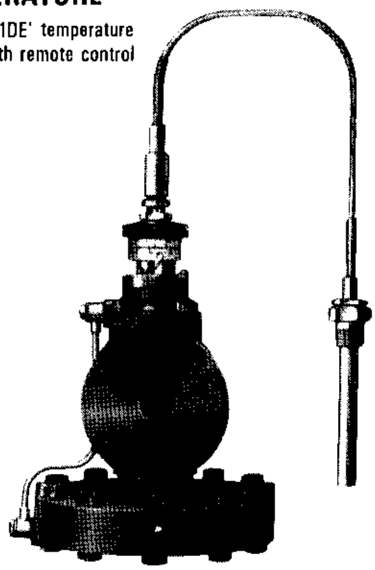

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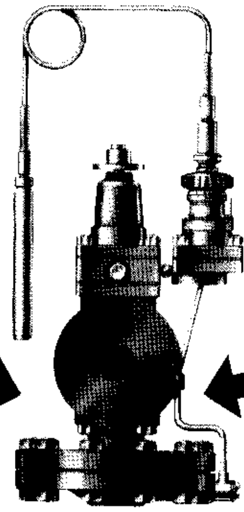

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Selling Maintenance to Management—the Use of Proper Costing

PART 1

By M. V. JARMAN, M.A., C.Eng., M.I.C.E., M.I.Mech.E.
Works Manager, Engineering Components Ltd.

Introduction

THIS paper is aimed at the maintenance manager and is concerned with the problem of persuading his top management, or Directing Authority, to accept a valid policy for maintenance.

One of the greatest problems facing the maintenance manager is the "apparent" unwillingness of the Directing Authority to understand or sympathise with the subject or case matter submitted by the manager; whether the Directing Authority be a public or private Board, Council, or Government Directorate.

The word "apparent" is stressed here with some emphasis, for one has to examine critically the way in which the case for maintenance is presented to the Directing Authority; it may not only be the question of presentation that detracts from the strength of the case, but the Directing Authority's lack of confidence in the maintenance manager's organisation, administration and methods of planning and control, perhaps reflected by the lack of a proper cost control system.

Undoubtedly, maintenance is one of the most difficult subjects to present to a non-technical body and one has to find the right language through which to operate and assert sufficient pressure on higher management to ensure coherent decision-making.

Whereas in the past a sympathetic Directing Authority might occasionally grant financial succour for maintenance on an ad hoc basis, there is nowadays a tightening-up on expenditure and a refusal to allocate financial resources on any basis unless a hard case is presented.

In this paper we are not concerned so much with the enlightened organisation where matters of maintenance are dealt with on a rational and successful basis, but rather with those authorities where the maintenance manager has difficulty in making any headway with the pursuance of a rational policy.

In the case of "Frustrated Maintenance Manager v. Unwilling Directing Authority", the defendant can too often claim unawareness or ignorance of the facts of the situation, and too often the brief for the plaintiff is badly presented, the final verdict of his financial Lordships being to award "no costs" to the plaintiff.

How is this case to be presented?—Indeed, why should it be presented at all? These are the questions to be answered.

To take the last point first, why is maintenance so vital?

Let us first place maintenance in its true national perspective.

I have quoted the following figures before but no excuse is made for their repetition, for their impact is undeniable and impact is one of the pre-requisites of a successful case.

The National Plan of 1964 reveals that something like £6,000 million per annum is spent on maintenance of buildings and plant and the fuel they consume, and a further similar amount is spent on new buildings and the installation of new plant.

On these facts alone no authority can but accept the vital importance of maintenance for the national economy.

This paper, however, is not setting out to discuss the national importance of maintenance, or more particularly building maintenance, but the impact of maintenance upon the local Directing Authority.

From the broad national scene, therefore, let us turn to the individual area where the maintenance manager is operating in an attempt to ascertain the sort of statistics he could collect in order that he may highlight the importance of maintenance in his own organisation as we are able to do on the national scene.

Maintenance costs can be related to the overall financial expenditure of the authority by stating the maintenance costs as a proportion of turnover, overhead costs or by proportion of profits or rate increases where it cannot fail to be substantial.

In industry, maintenance costs can be compared with the equivalent annual sum on the revenue account which would yield a 1% dividend to the shareholders—an instant appetizer for the financial authority.

In my last company the figures were approximately as follows:

Maintenance as a proportion of turnover	5%
Maintenance as a proportion of overhead costs	20%
Maintenance as an equivalent dividend yield	40%

so surely we can present the first part of our case "Is maintenance important?" by presenting the overall cost figures in the most suitable form for impressing the Directing Authority.

Having put maintenance in a financial perspective to the local Directing Authority, a precarious position arises—the Directing Authority may demand an explanation for this expenditure which the manager may be unable to give, or the Directing Authority may simply demand a reduction in these costs. Finance for maintenance, and building maintenance in particular, is too easily reduced when available finance is viewed critically.

Whichever the attitude, the next step is very much the same—the preparation of a case to confirm the need for the maintenance expenditure requested.

It is my view that a good case can only be presented if there is a dynamic administration behind the maintenance manager, one of the chief facets of which will be a total concept of cost control. Not only is the Directing Authority's confidence in the maintenance organisation thereby increased, resulting in a more ready acceptance of a case for maintenance, but the case itself is all the more easily prepared from the vital information which is all the more readily available.

The Concept of Total Cost Control

In order that the maintenance manager should be able to sell maintenance to the Directing Authority therefore, and indeed carry out his responsibilities effectively as a functional manager, it is essential that he is fully equipped with all the aids that total cost control can offer.

The remainder of this paper is devoted to setting out the principles of cost control, from overall consideration to the detailed techniques involved, on the premise that once this aspect of management has been absorbed and acted upon by the maintenance manager, he is in a powerful position, both as a line manager and a manager responsible for proposing and executing a maintenance policy.

Total cost control, as discussed in this paper, may be summarised briefly to include the following:—

A sound knowledge of the relationship between budgeting and finance.

A logical break-down of the budget into specific sections under capital and revenue, with particular reference to renewals and replacements.

A reasonable assessment of the factors affecting the budget, including a plan for maintenance.

A method of calculating economic assessments of capital, renewal and replacement expenditures, using discounted cash flow analysis.

A quantifiable evaluation of the results of non-maintenance, such as lost amenities or production due to break-down, excessive running costs, and increased health hazards.

Budgetary Control, including a calendar programme for authorisation and implementation of plans for capital, renewal and replacement expenditures.

The use of powerful costing techniques, including cost coding and classification systems, methods of cost collation and investigation, and feed-back of relevant cost information for control purposes.

Costing of stores items to ensure accurate and instantaneous recording of the cost of materials usage.

Cost control in fact covers the presentation and analysis of information in such a way as to assist management in the creation of a policy and the day-to-day operation of an undertaking through the organisation structure.

It consists of three main functions which could be defined as follows:—

1. The Budget, which equates the available financial resources to the planned expenditure.

2. Budgetary Control, which is the broad control to be affected throughout the year, whereby expenditure is seen to conform to the budget plan and variations are seen to occur for known reasons.

3. Costing Techniques, which should enable actual costs and expenditure to be assembled in such a way that frequent comparisons can be made with the budget

plan and a close watch can be kept on the internal efficiency of the organisation, by internal and external comparison.

A research report, produced by the Institute of Chartered Accountants in 1947, states, "It is a fact, one of the most important conclusions we have reached is that sound costing technique places the same emphasis on cost control as cost ascertainment."

Relationship between Budget and Finance

Before discussing the formulation of the Budget in detail it is important to relate the Budget to the method of financing it; an important aid, in any event, to efficient management and selling maintenance to the Directing Authority.

Finance is provided from either Capital or Revenue sources.

Capital is normally provided for new works only and Revenue for running costs, but one factor upsets this apparently simple statement—and that is the expenditure on renewal or replacement, often large sums that increase the revenue budget by a non-uniform and substantial extent, but which are carried out only to reduce the annual revenue costs of the items affected.

It is my opinion that these expenditures could be treated as capital and a study of this might well provide a change in attitude of both the Directing and the Tax Authorities.

To relate maintenance to finance let us consider the following table depicting the present method of finance:—

FINANCE

	Revenue	*Capital*
Provided from	Revenue Account	Loans, grants and revenue; surplus from rates and taxes; new share capital and loans and surplus profits, depreciation and grants
For	Routine Maintenance of Existing Assets, plus general Renewals and Replacements	Purchase and Construction or Installation of New Assets, plus some specific Renewals and Replacements

The faults with this system, particularly in industry—and no doubt the same parallel occurs in the public sector—are:

1. That whereas "depreciation" should provide just that financial aid required for renewal or replacement—the non-recurrent maintenance costs—too often it is just a "book" figure and the cash is simply not available where it ought to be—in "current assets". There is a tendency to invest the capital in new works only and pay insufficient regard, or indeed no regard, to a replacement policy.

One interesting example of separate treatment for renewal and replacement is illustrated in the hospital services where I understand that forecasts of expenditure are prepared in a form which segregates "developments and improvements not resulting from new capital developments"; the cause for concern here is that these costs are specially treated as "prunable".

2. There is a tendency to pay for renewals and replacements by reducing expenditure on routine maintenance.

3. Variations in cash flow available (e.g. from profits) can cause a serious disruption in plans for renewals and replacements. Delayed expenditure in these areas means higher costs later on, due to increased prices, and waste of revenue resources in the meantime, due to higher running costs; it is a pity that the peaks and troughs of expenditure in this direction are not levelled out through a better manipulation of financial resources.

These tendencies are alien to proper maintenance management and the maintenance manager could more effectively state his case if all items of renewal and replacement were transferred to the capital side.

Larger items of machinery are generally paid for out of capital, but items such as roof renewals or replacement of building services are often treated as write off or revenue expenditures. The whole treatment of the subject leaves much to be desired.

To clarify and reinforce maintenance policy, could we not look at capital and maintenance expenditure budgets for new and existing assets in the following way:

1. New Assets. When any new capital assets are considered and authorised the financial approval to cover:
   - (*a*) The capital cost of the project.
   - (*b*) The depreciation monies (capital) for that project, set aside in such a way that cash will be available at specific times for renewal or replacement, i.e. expenditure apart from routine maintenance.
   - (*c*) The running cost of that project covering:
     - (i) Routine maintaining costs to keep the assets in good order.
     - (ii) Cost of fuel, i.e. heat, light and power.

The project is thus considered as a whole from initial conception.

2. Existing Assets. With existing assets the condition of those assets to be evaluated, and monies set aside through the capital account for planned renewal and replacement both at the present time and for future use.

   The revenue budget to cover only routine, and therefore stable, running costs.

3. Central Government Budgets. Before leaving this subject it is interesting to note that in only one instance do capital and revenue cash flows stem from the same source—in central Government; in all

other cases, public and private, there are separate capital and revenue accounts.

In Government accounts, the Exchequer system of finance can only ensure a check of expenditure against estimate.

This system does not indicate future commitment against capital expenditure, i.e. maintenance costs which will be incurred from new buildings or works. Surely it is essential that the Government is able to take account of increases in expenditure of this kind prior to sanctioning of capital developments. This policy might change the Treasury's attitude with advantage from a tendency to reduce capital expenditure at the expense of increased maintenance costs.

Preparation of the Capital Budget

As stated previously, the capital budget should be considered in two parts; new assets and renewal or replacement of existing assets. For convenience and regardless of discussion, the latter has been included in this section of the paper rather than under revenue budget.

For new assets the budget should not only cover the capital costs of the development, but should also refer to the effect of that development on the revenue budget.

According to a survey carried out a short while ago by the Institute of Municipal Treasurers and Accountants, approximately one third of local authorities already do this, and in fact express the commitment of runnings costs in terms of the additional rate in the pound—a very good example.

However, if the maintenance manager is really going to state his case completely at the time of approval of capital budgets he must develop his understanding of the concept of total commitment even further, using the technique of discounted cash flow analysis.

This technique is now in general use and has been adopted by the Government itself in the publication "Investment Appraisal" (H.M.S.O. 1964).

It is my opinion that maintenance managers should use this technique personally rather than leave it to the accountant, for in using it he acquires a fuller understanding of an investment-pay back relationship so essential in the case for maintenance.

Discounted cash flow analysis takes into account the following factors: Running costs of maintenance and fuel; resale value; depreciation; discount factor; investment grants; tax allowances; period of life assumed for the building or plant.

The first of these factors, running costs, will be estimated from a knowledge of like developments or installations and their historical costs—which cannot be calculated accurately without a proper costing system.

There is also the further development of running cost calculations by the employment of the "cost in use" technique, a subject of present-day studies; when "costs is use" (of various items over their estimated life) have been sufficiently studied and reported upon they will be invaluable for inclusion into the calculations of running costs and total commitment.

For renewals and replacements of existing assets, the case is best submitted using precisely the same technique.

Accurate costing and re-allocation of costs are of prime importance here, enabling realistic assessments to be made of those areas in which it is possible to achieve savings in running or maintenance costs by means of expenditure on renewals or replacements, and these projects should then be included in budgets of capital expenditures.

The following list indicates example of such projects:

- Replacement of plant and equipment with excessive fuel costs.
- Replacement of plant and equipment with high maintenance or break-down costs, or under-utilisation due to obsolescence.
- Installation of additional services equipment to reduce maintenance costs on production machinery (e.g. air-drying plant for compressed air).
- Provision of mechanised equipment for maintenance.
- Provision of automatic control valves and metering equipment for all services, to control and economise on the use of steam, and to provide facilities for recording consumptions for cost control and tackling the problems of waste detection.
- Provision of automatic lighting controls to reduce electricity costs.

An example of such a project is described in Appendix IV, illustrating the result of investing capital to replace a number of old boiler houses with one new boiler house, and the consequent discounted cash flow analysis.

The running costs in this case were reduced by 28 per cent and the investment was shown to be yielding a net return of 20 per cent after tax over a 20 year plant life — quite a satisfactory investment, and incidentally a close confirmation of the calculations upon which the original proposals were based.

It was undoubtedly the detail of the cost analysis and the translation of the project into financial terms in the original proposals that "sold" the project to the top management.

Preparation of the Revenue Budget

Although budgeting has been developed more by the larger organisations, owing to the larger savings that can be achieved by a tighter control of costs, it is just as important in the smaller concern; for we should always be concerned with percentage savings, whether locally or nationally.

Budgets can be compiled in two ways; firstly by the administration asking the cost accountant to submit budgets for all departments; secondly, by asking departmental managers to submit budgets in a recognised fashion with the help of the cost accountant. The latter method must surely be the better—the manager compiles the budget—he must support it and co-operate later with the cost accountant in the control of it.

With budgets prepared by accountants, the manager will automatically blame the calculations and not himself when things go wrong. With his own budget, however, he will be the more likely to make the effort to achieve the targets which will not normally be unrealistic.

The Revenue Budget should be founded on estimates of the work to be done and the manpower, plant and materials needed to perform it; the work to be done being that required to fulfil the objects of the organisation.

The budget includes the following sections:—

1. Overheads and Staffing. Increased estimates will allow for increase in salaries and extra staff either for additional areas, new works or an increase in technical or technological strength. This last item must be seen to result in better planning and, where possible, economies in maintenance.

   Any increase in overheads, whether new staff or teams of consultants employed on organisation appraisal or work and method study must be watched and re-appraised annually to evaluate the worth of such expenditure.

2. Power, Heat and Light, etc. Increased estimates will include for increased costs of tariffs and fuels, and additional new buildings constructed. The only radical changes would result from planned economising by re-development of the services to obtain lower running costs.

3. Maintenance of Buildings and Plant. Many budgets are based on two factors:—

   (*a*) minor maintenance, consisting of small items where one would simply estimate "this year's cost plus 5 per cent for next year"!

   (*b*) major maintenance, consisting of specific major items that happen to come to mind.

More satisfactory budgets can only be brought about by planned maintenance and an accurate assessment of the resulting work load, backed up by an adequate costing system.

Major items of maintenance fall into two categories:—

1. Investment of money to replace or eliminate areas of high maintenance costs (e.g. new roofs), or restore lost amenities; which could, as I have stated, well be treated as capital and has been discussed in the previous section.

2. Placing of contracts for large expenditures on planned routine maintenance (e.g. contracts for painting items which conform to a known periodicity).

There is continuous interplay between these two categories. The replacement of high maintenance cost areas or placing of contracts for work previously carried out by direct labour should, in theory, reduce the costs of minor maintenance, although too often in practice it may simply result in the existing labour force carrying out a back-log of maintenance work that it could not cover before.

When drawing up the budget the following factors should be considered:—

1. Demand. Changes in maintenance or running costs due to change in production schedules or customer service.

2. Limited resources. Limitations made by financial ceilings for cash flow available; though a request for less expenditure than is known to be necessary for proper maintenance should not be made without a clear statement to that effect.

3. Standard costs. Estimated total costs based on what each unit of output or service should cost at a reasonable efficiency of operation, making allowances for fixed overhead costs that do not vary with output or service.

4. Standards of performance. Estimating on agreed standards of performance expressed as a ratio between labour and materials, and output, thereby calculating resources needed to meet the demands.

5. Standards of service. Where there are large numbers of approximately equal claims on the same service, e.g. local authority housing repairs and maintenance, where an allowance can be made per house, per type, per annum and the total budget required from the housing repairs above calculated accordingly.

   Any reduction in resources available may then be uniformly spread over expenditure per annum, per house or the periodicity lengthened to retain the same standard of work executed although involving reduced standards of the property due to the lengthening of the maintenance period.

6. Cycles of maintenance work. Estimating on the basis of periodicity where the periods are known either by Statute (Factory Acts) or from known standards of service. There is a danger in extending periods through lack of resources as this results in an increasing back-log of work that may never be reduced, with consequent lowering of service or breaking of statutory requirements—this particularly applies to painting programmes.

7. Programmes of work. Estimating budget costs from planned maintenance schedules and cycles. Where it is possible to base budgets on accurate estimates of labour and material costs for known maintenance schedules and operations a powerful case is made for budget approval.

Budgetary Control

It is sometimes said that budgetary control fails because of the tendency of departmental managers to manipulate expenses and show false accord with the budget plan; that top management, after demanding detailed budgets, lose interest and either allow manipulation of expenses or unrealistically cut costs at a later date without due regard to the real value of the items deleted. It is not budgetary control that has failed here, but the top management itself who, after paying lip service to it, have operated a control so loose and lacking in understanding as to be almost valueless.

The quality of budgetary control, and the results obtained thereby, depend entirely upon the dynamic action of intelligent top and departmental management, initially and continuously to completion of the budget programme.

Complaints of unexpended budget allowances at the end of the year, or the mad rush to use them up before the end of the year should be carefully analysed. Is it a case of management restriction on cash releases during the year, a lack of initiative by departmental managers, a lack of calendar programme for implementatuon or lack of staff for design or execution of work? This analysis should result in either a strong representation to top management during the subsequent year's budget discussion, a critical self-analysis, an appeal for more staff, a more realistic and reduced budget request for the ensuing year, or a demand for longer term budgets in certain areas.

It goes without saying that modifications to budgets need to be carefully controlled, but it is worthwhile pointing out examples at this stage as they point to important principles.

In the Hospital Service it was possible some time ago to transfer monies liberally from Maintenance Allocation to Development Improvements and, as this could have led to cutting maintenance costs below the level required for maintaining assets in working order, the Minister of Health tried to guard against it, knowing that this would lead in the long run to greater dilapidation and increased expenditure, by insisting that a certain proportion of allocated funds be devoted to building maintenance. It is understood, however, that non-recurrent items such as renewals and replacements included in revenue budgets still give rise to anxiety due to their being dispensable under financial clamp-downs.

Another interesting example of modifications to budget was the subject of a directive issued by the Minister of Health in 1957, and illustrates a worthwhile principle, viz.:—

> "It is proper that money saved by measures of economy and increased efficiency should be available to finance in the same year additional developments and improvements; but developments and improvements involving additional expenditure in future years should not be financed in this way unless the measures producing the savings have these equivalent continuing effects in future years."

Referring again to Hospital Board budgets, one author stated that "this leaves an apparently small number of balanced items where adjustment can be made if necessary to keep within the budget. Chief amongst these are building maintenance and purchase of furniture, crockery, bedding and other domestic equipment". This indicates an ease of reducing building maintenance costs which could be disturbing.

Finally, it would indeed be wrong to evaluate the efficiency of maintenance by looking at total revenue budget reductions—the savings achieved by better maintenance planning or other means in one area may have been used to improve standards or amenities elsewhere without incurring extra expenditure overall.

(To be continued)

'MINUTES' MADE AT RATE OF 60 PRINTS A MINUTE

Minutes of the discussions during a seminar for hospital administrators to be held in Sheffield by Rank Xerox, were printed, collated into sets and handed to the guests.

This demonstration of the fast turnround of paperwork and urgent communications was made possible by the latest Rank Xerox copier/duplicator, the 3600 model, which makes a print-a-second onto ordinary, unsensitised paper. Not only that, but the 3600 makes sharp, dry, permanent prints direct from the original, (no master is needed) and with the linked sorter, collates them automatically into sets, ready for stapling or binding.

BIG OVERSEAS INTEREST IN BRITISH OPERATING THEATRES

After an eight-month, 9,000-mile tour of Western and Eastern Europe, Medic-Ex, the mobile exhibition which formed the first coordinated export drive by British medical equipment manufacturers, returned to this country on September 3rd.

In 32 weeks, Medic-Ex has crossed 46 frontiers to exhibit in every continental country, and Sweden, and to spend the last two months in Iron Curtain countries.

Honeywell, whose modular operating theatre system is a main feature of the exhibit, have received over £½ million worth of enquiries. Fifty overseas prospects have asked for detailed theatre system layouts.

The other main exhibitor is Portex who showed their range of surgical and medical plastic products.

NEW LITERATURE FROM HOVAL

Two pieces of literature on the newly-introduced Hoval automatic thermostatic radiator valve are now available from Hoval Boilers (U.K.), Ltd., Northway House, High Road, Whetstone, London, N.20. These valves—fitted instead of an ordinary radiator valve—are designed to maintain room temperature at the level set on the control knob.

The first of the two new pieces of literature is a 4-page leaflet, describing in detail the functions and applications.

The second is a pocket-sized 12-page booklet, containing detailed installation and operating instructions.

A GUIDE TO CEILING PANELS

A new publication, "A Quick Guide to Bowater Ceiling Panels", includes the full range of Bowater Ceilings -Mineral Board and Insulation Board—together with their respective fixing systems.

Copies are available on request from Bowaters Sales Company Ltd., Building Products Division, Ceilings Department, 87, King's Avenue, London, S.W.4.

Electrical Services in Hospitals

PART 3

By J. H. LEVERTON, B.Sc. (Eng), C.Eng., F.I.E.E.
Assistant Regional Engineer, N.E. Metropolitan R.H.B.

Boiler Houses

The majority of Hospital Projects will call for the provision of a main steam boiler house which will either be coal or oil fired according to the economics of the particular area of the country and site limitations with regard to noise, dust, fuel, handling etc.

Solid fuel installations will include automatic stokers with their associated coal handling plant, whilst oil fired plants will include burners, heating and pumping units and transfer pumps. In both cases there will be auxiliaries such as feed pumps, I.D. and F.D. fans and instruments etc.

Each boiler should be controlled by its individual control panel which should incorporate instrumentation, thus enabling any boiler and its controls to be isolated for maintenance purposes without interference to any others.

In addition, one further panel should be provided for all common controls, instrumentation and electrical supplies.

Wiring should be carried out in heat resisting P.V.C. cable in conduit where there is no likelihood of exposure to high temperatures, but wiring terminating in hot areas (i.e. burners and I.D. fans) should be in M.I.C.C. Routes should be selected so that there is no risk of damage to cabling during maintenance operations such as tube cleaning or replacement. Flexible connections in heat resisting cable should be used for components which need regular removal for cleaning etc. Generally speaking, cable tray run at high level across the top of the boiler fronts is the most satisfactory solution.

Where pumps or other units are supplied in duplicate for stand-by purposes, each unit should be wired separately to an individual fuse way on the distribution board. This will ensure that a fault on one unit that causes a fuse to blow will not delay the bringing into use of the other unit. In addition, it will be possible to test a unit after overhaul without shutting down the unit on line.

Calorifier Rooms

Supplies in these rooms will be required mainly for circulating pumps, condense return pumps, sump pumps and control circuits. Pump units will normally be provided in pairs and supply arrangements should be as described above for boiler houses. Wiring should be in heat resisting P.V.C. cable in conduit, as temperatures will be fairly high in these areas.

Control equipment will be obtained from specialist manufacturers and composite wiring diagrams will need to be prepared for each unit.

For the control of sump pumps, either float switches or electrode controls will be provided.

Ventilation Plants

Ventilation plant rooms will house a considerable number of units such as fans, filters, heater batteries, cooler batteries, humidifiers etc., most of which require electrical supplies, control wiring or alarm wiring. In addition, electrical interlocking will be required to ensure correct sequence of starting up.

(*a*) All motors should be provided with adequate overload and single phasing protection. This applies particularly to spinning disc humidifiers which will consist of a water pump motor and several small motors driving the spinning discs. These motors will all be required to run at the same time and may be controlled by a common starter, but individual protection may be provided by means of triple pole miniature circuit breakers.

(*b*) In order to provide correct sequence control it is common practice to feed the contactor coil of starter B from the outgoing terminals of starter A. This type of connection will prevent a normal isolator on starter B from completely isolating all parts of the starter. This must be prevented either by providing auxiliary contacts on the isolator or interposing a relay in the control circuit.

Wiring in these rooms may be carried out with P.V.C. insulated cable in conduit as temperatures are not likely to be excessive. Runs must be carefully selected as there will be a number of removable panels on trunking for cleaning and inspection purposes in addition to heater batteries and filters which require frequent removal for maintenance purposes. No conduit runs should be allowed to interfere with these operations. In addition, there will be a number of sensing units in the duct work which should be connected by means of flexible cables.

Many units will call for remote controls and warning and pilot lights which may be sited at considerable distance from the plant room, and allowance must be made for these runs in the electrical conduit.

Cooling units will generally be provided for Operating Theatre and other special plants. In order to avoid noise nuisance the compressors and cooling towers may be sited remote from plant rooms and, again, interconnecting control wiring will be needed.

Water Supplies

The advent of high buildings and the reduction in pressures available from mains due to increased water demands has led to the need for water pressurising units in order to feed high level storage tanks. Water from the mains is fed to ground level storage tanks which provide about 2/3rds of the necessary storage and from these is pumped to high level tanks. The pumping units are usually self-contained with all controls delivered as a packaged unit and it is therefore necessary only to provide suitable electrical supplies to an isolator.

Further small units may also be provided for pressurising drinking water mains and also fire hose reel supplies, and these again will most likely be packaged units.

Water treatment or softening units will need to be supplied in most hospitals. These will be of the automatic type and will incorporate pumps and automatic regeneration controls.

Sewage Pumping

Sewage pumping units may be required, usually, only for parts of complete hospitals which may be too low for natural flow of sewage. Duplicate pumps are always provided and control should be by means of electrodes rather than float switches. Wiring should be in M.I.C.C. cable as the atmosphere will be moist and corrosive, and control gear should be of the waterproof pattern.

Diagnostic X-ray Department

X-ray Departments need special treatment due to the heavy loads taken by the equipment and also due to the need to avoid causing breaks in the protection of the walls, etc.

All the equipment is supplied and erected by specialist manufacturers but the mains supply and the provision of all interconnecting wiring will be carried out by the electrical contractor.

For this purpose all manufacturers provide large scale dimensioned plans of the layout of the equipment in the room together with detailed schedules of interconnecting wiring. Present day costs will be of the order of £500 for each room.

The schedules indicate the positions of termination of wiring and the length of tails to be left. The actual connecting up is carried out by the specialist. Some runs may incorporate up to 50 cables varying in size from 3/·029 to 19/·083.

All generators incorporate a transformer with a primary wound for 346/500 volts, single phase with tappings for this range. For other single phase voltages and for 3 phase supplies an auto transformer is normally supplied.

The following table shows the maximum voltage drop allowable with a load of 50 amps at the main switch in the X-ray room. (This switch must be mounted adjacent to the control panel.)

Supply Volts	*Maximum Resistance (Ohms)*	*Maximum drop at 50 amps (V)*
200	0·10	5
220	0·15	7·5
230	0·16	8·0
240	0.18	9·0
250	0·20	10·0
346	0·43	22·5
400	0·65	32·5
415	0·7	35
440	0·8	40
500	1·0	50

Approximate currents taken by the unit when in operation are as follows:—

For periods not exceeding	*200/250 V Single Phase*	*346/500 V Single Phase*	*346/500 V Three Phase **
0·1 sec.	200 A	150	150
1·0 sec.	150 A	100	100
10·0 sec.	50 A	30	30
Continuous	15 A	10	10

*Current in 1 phase. Current in other 2 phases will be ½ this value.

It will be found most convenient to use 2 phases of a 3 phase supply to provide a single phase supply at 346/500 V and, where several sets are provided, these should be distributed over the three phases and allowance made for diversity.

A neutral will also be required, as most auxiliaries such as the motor driven table operate from a 240 V single phase supply.

The figures given above are provided by Messrs Watson and Sons Ltd., but apply to most makes of Unit. In rare cases, units of exceptionally high output may be provided and these may operate from a 3 phase supply.

Most of the large conduit and trunking runs will be surface in the room but if it is decided to sink conduit and boxes in the wall surface precautions must be taken to ensure that the protection is not interfered with. This protection will take one of the following forms:

(*a*) Lead cored ply panels mounted on lightweight partitions.

(*b*) Solid partitions of brick or concrete, usually not less than 9″ thick and plastered with normal plaster.

(*c*) Brick or block partitions less than 9″ thick and plastered with barium plaster normally between ⅝ in. and 1½ in. thick.

In the case of (*a*) conduits must either be run on the surface or within the partition behind the lead protection. Where holes are cut for boxes for switches or sockets, a piece of lead 3 mm. thick should be fixed to the back

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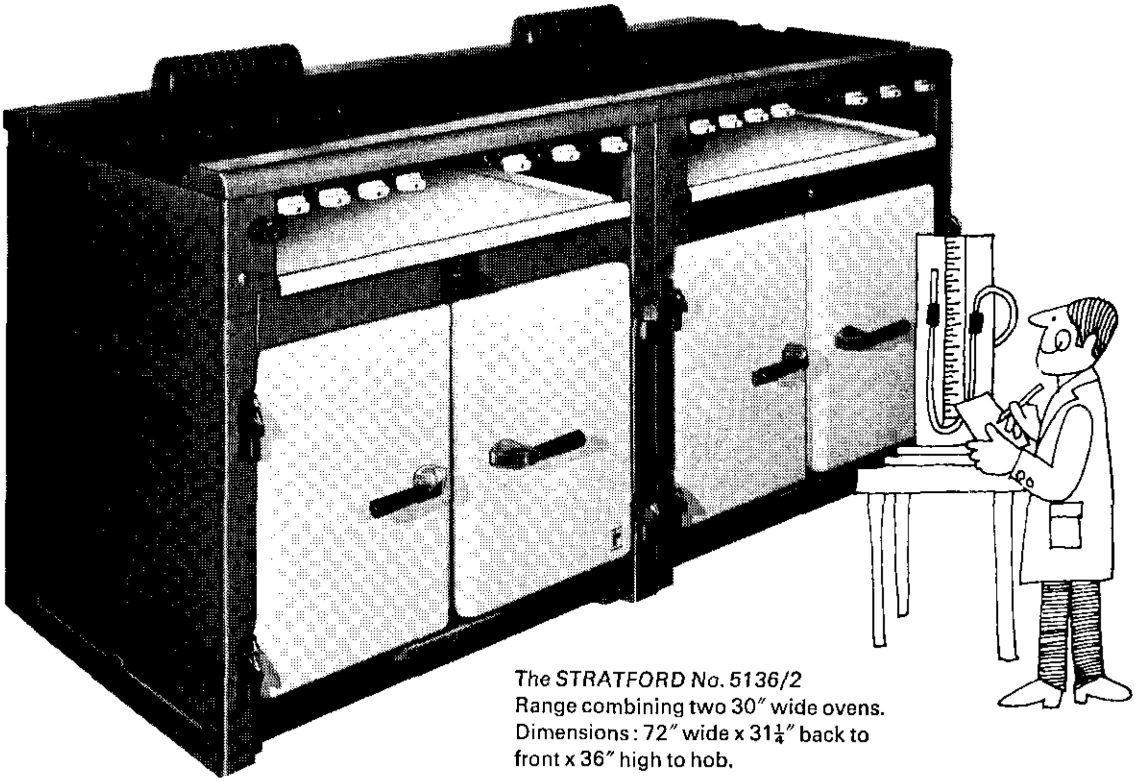

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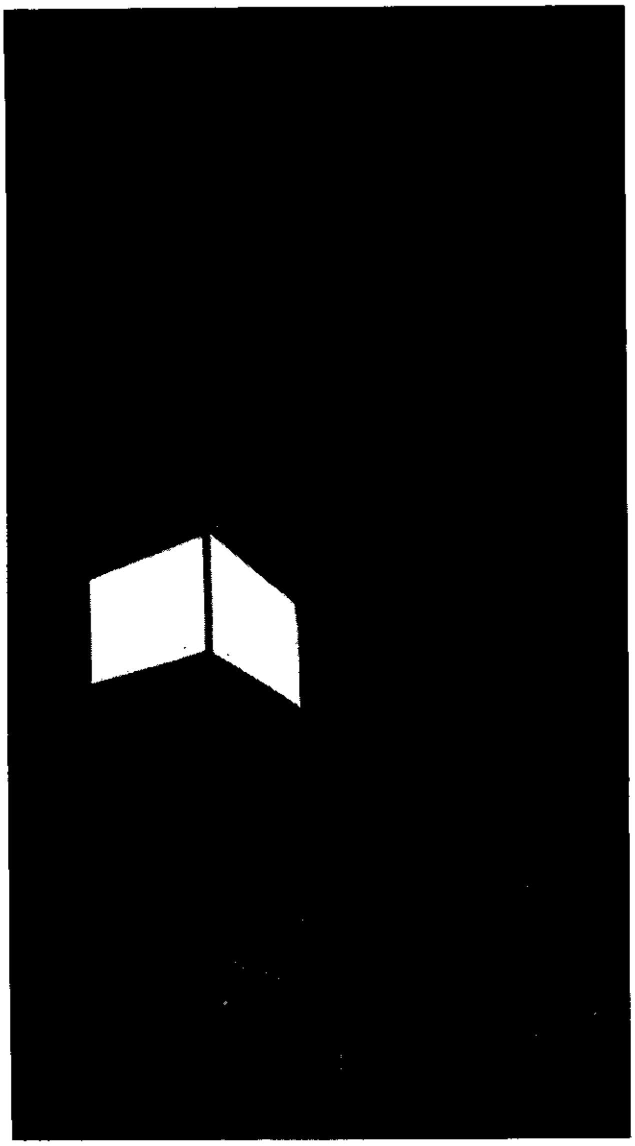

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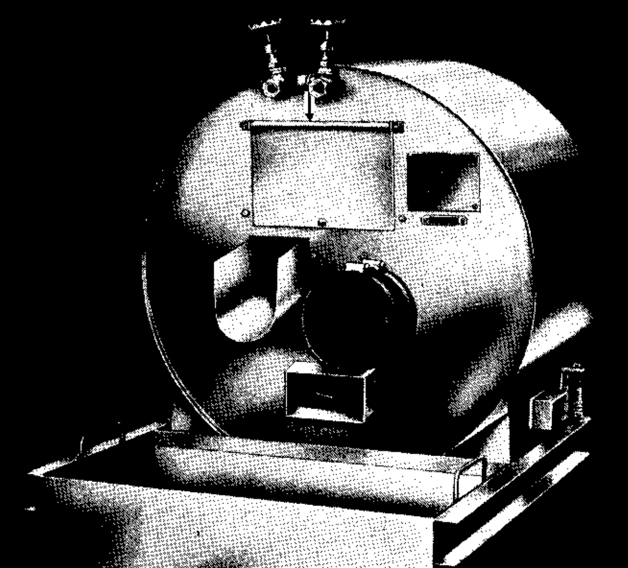

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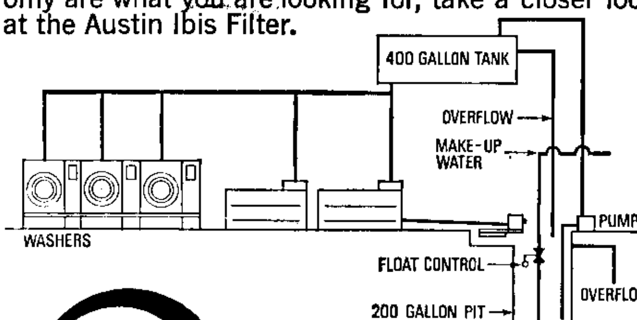

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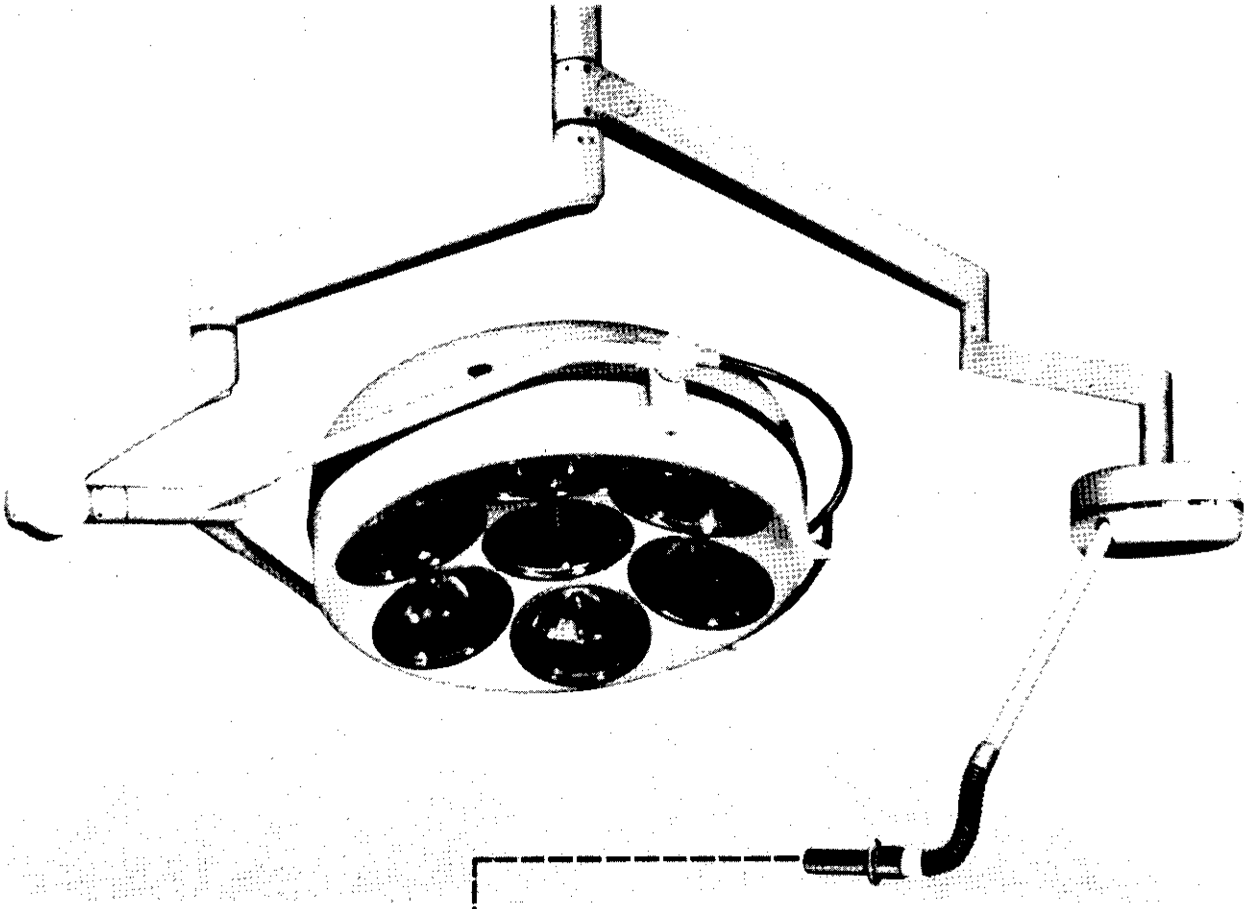

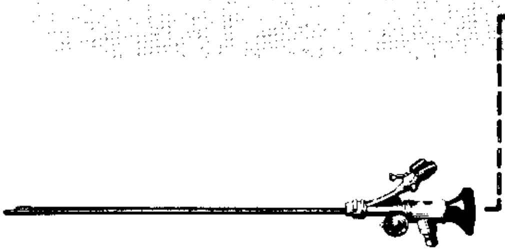

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of the box with about 25% overlap to compensate for the hole.

For solid construction (*b*) chases for conduits up to ¾in. may be allowed but should be kept to a minimum and horizontal runs should be at a height of not less than 6ft. 6in. unless on the surface.

Where barium plaster is used (*c*) all conduits to be sunk must be chased in to such a depth that the full thickness of plaster will be maintained over them. 3 mm. lead pads must be fitted to the backs of all boxes.

Whenever it is necessary to break the protection the approval of the Physicist responsible for the design must be obtained.

Dark Rooms

Dark rooms for X-ray departments will be equipped with a combination of the following units requiring connection to the Mains.

(*a*) Manual processing units. These contain thermostatically controlled immersion heaters to maintain correct temperatures of solutions. Connection will be by means of a 13 A switch socket.

(*b*) Drying cabinets for drying films by means of forced circulation of hot air. The loading will not exceed 3 kW and a 13 A socket will be required.

(*c*) Automatic processing units into which exposed films are fed at the darkroom side to emerge outside the dark room completely processed and dried in about 6/7 minutes. The loading of these units is about 25 A and the supply should terminate in a suitable isolator adjacent to the unit. Wiring from this point will be carried out by the supplier.

(*d*) Automatic film driers into which wet processed films are fed to emerge dry in 3/4 minutes. These may be fixed in the wall between the dark room and viewing room or be free standing in either. The loading will be about 23 A and the supply by means of 30 A switch fuse or 30 A socket.

Adequate numbers of socket must be provided in darkrooms as a number of accessories such as viewing screens, silver recovery units, film numbering and trimming machines etc., are used. It is preferable to use switches and sockets with plastic plates, as metallic finished rapidly deteriorate due to the presence of chemicals and operation by contaminated fingers.

In many darkrooms a film hopper for the storage of unexposed films is provided under the dry bench. This hopper is light-proof and fitted with a door switch connected to the white light in the roof so as to ensure that it is switched off when the hopper is opened. Sockets used for viewing screens should also be connected to this switch.

Radiotherapy

Radiotherapy units are used for treatment as opposed to diagnostic purposes. The source of radiation is a high energy radio active substance, usually cobalt and the mains load of these units is relatively small as it is confined to control and interlock purposes. As it is not possible to stop radiation from these sources they are housed in massive protected heads and the movement of these is motor operated. Controls are situated on a panel or console outside the protection of the room.

The protection consists of mass dense concrete at least 2ft. 3in. in thickness and entry to the room is via a labyrinth as it is not possible to provide doors having adequate protective properties.

Normal doors will usually be provided at the entrance to the labyrinth in order to provide a means of interlocking for safety purposes.

The units are supplied by and installed by specialist manufacturers who provide full details of supplies and external wiring required. Conduits up to 1″ may be recessed in the concrete but must be cast in situ and not chased in. Care should be taken to ensure that parallel runs inside and outside the concrete are at different positions so that a minimum reduction of wall thickness is achieved. A spare trunking run not less than 2″×3″ should be run at high level through the labyrinth to terminate in a 4″×4″ box at a convenient level adjacent to the control panel outside and at a similar height inside the room. This is to accommodate any runs of cabling required either permanently or temporarily for monitoring, calibrating, etc.

Here again it is essential that agreement be reached between the Engineers and the Physicist responsible for the protection as to the routes of any conduits, trunking etc., before any construction work is commenced. In view of the difficulties in casting concrete in such masses, agreement must be reached with the structural Engineer.

In order to maintain effective communication between the operator at the control panel and the patient within the room, 2 way loudspeaker communication is necessary for the operator to give instructions and re-assurance to the patient. It is also necessary, on occasions, for the operator to be able to observe the far side of the patient but the provision of a large adjustable mirror is just as effective, more reliable and much cheaper than closed circuit television.

In a few instances, superficial X-ray machines may be installed. These units require no more protection than a diagnostic unit as their output is very low and will operate from a standard 13A socket.

The use of linear accelerators is at present confined to Teaching Hospitals where they can be used for research work in addition to treatment. The cost and size are, however, becoming less and it is possible that some may be installed in other hospitals in the future. It will be necessary to obtain details of the load and wiring from the manufacturers of these highly specialised units.

Kitchens

Where gas and steam are available it is unusual to provide an all electric kitchen for the following reasons:—

(*a*) Running costs will usually be higher for electricity.

(*b*) Maintenance costs will be higher.

(*c*) The load will be quite high and the cost of providing alternative supplies will be prohibitive.

It is preferable to provide the equipment required partly for use on gas and partly electricity, thus providing some safeguard in the event of failure of either supply.

Many items of equipment such as small mixers, peelers etc., will require the provision of 13A sockets but larger items should be supplied through switch fuses of adequate rating, and permanent wiring.

The main methods of distribution of food are the plated meal system and the heated trolley system. In the plated food system supplies will be required for the following major items of equipment:—

(*a*) Heater units for pre-heating the metal pellets used for keeping the meals hot after plating.

(*b*) Supplies to portable baine-maries used for serving in the kitchen.

(*c*) Motor drives for the conveyor belt units.

The food is distributed in unheated trolleys subsequent to plating in the kitchen.

The principal alternative system is the distribution of food in bulk in heated containers for serving in the wards.

The heated containers will have a loading of 2–3 kW depending on size and there is practically no diversity on this load as the containers will all be switched on in a loading bay in the kitchen area some hour or so before meal time and, in most cases, will be plugged in the ward kitchens to keep food warm whilst serving. The time of serving the evening meal is quite likely to coincide with the peak load of other services in the hospital.

With a plated meal system particularly, and possibly with other systems, all crockery, cutlery etc., is returned dirty from the Wards to the central washup area adjacent to the main kitchen. This area will require a large washing-up machine which may well have a load of up to 8 h.p. in motors and 24 kW in heaters if steam is not available.

Cold Storage will be provided for fish, fruit, dairy produce etc., but these will be standard commercial units and need no special treatment.

Experiments are proceeding on the use of deep frozen food and H.F. induction heating. So far this method has not proved acceptable as there are severe limitations on the type of food that can be so treated and the cost is too high. Should it be possible to adapt this system then the cooking load will be dispersed to the Ward Kitchens and will, of course, be electric. Large deep-freezers will also be needed in central stores and small ones in Wards.

Sterilizing

With the discovery that certain spores are resistant to boiling water temperature, sterilizing is now carried out by autoclaves operating from steam at about 32 lbs./sq. in. pressure. Where main boiler steam is available this will be used and electrical supplies will be required for pilot lights and automatic controls. Units used for sterilizing dressings will incorporate a high vacuum pump unit.

With the advent of Central Sterile Supply Departments (C.S.S.D.), apart from bed-pan sterilizers in certain types of wards, Operating Theatres, Delivery Suites and Pharmacies there should be no sterilizers outside this area.

The C.S.S.D. will impose a considerable electrical load incorporating the following items of equipment:

(*a*) Sonic washers.

(*b*) Washing machines for glass ware.

(*c*) Washing machines for fabrics.

(*d*) Infra red sterilizers.

(*e*) Hot air ovens.

(*f*) Autoclaves.

(*g*) Air compressors for capping machines.

Where steam is not available from a central source for sterilizers, small steam raising units will be necessary and these may be heated either by gas or electricity. Electric units are normally automatic with water level controls and in view of difficulties which have been experienced in the past, the following special precautions must be taken:

(*a*) The boiler pressure to be controlled by a pressure-stat to operate the heater and feed pump.

(*b*) 2 Safety valves to be fitted.

(*c*) An immersion thermostat must be fitted to de-energise a separate contactor in the heater circuit which will lock-out and operate an alarm circuit.

(*d*) The heaters are protected during filling or emptying.

(*e*) The heaters are switched off on failure of make-up water.

(*f*) The heaters and feed pump are energised together during normal working.

(*g*) Turbulence will not cause hunting of contactors.

Heating

Where steam or hot water is readily available for heating from a central source, the cost of electric heating cannot be justified. The two main uses for it will be found in off season heating and isolated buildings. In certain rooms, such as Consulting Rooms where patients will be scantily clad, it will be necessary to provide heat when the central system supplying the remainder of the hospital is shut down early and late summer.

Fixed units should be provided, preferably at high level in the form of infra-red, non luminous panel heaters or blower units. Where space permits, tubular heaters or convectors may be used. Pilot lights must be incorporated in the control of all non-luminous sources, and thermostatic control of these units should be included.

In the use of off peak heating there are many problems peculiar to hospitals, not the least of which is the 24 hour occupation of large areas. Where a building is subject to intermittent occupation, such as a social centre or recreation hall, off-peak underfloor heating can be used to provide background or conditioning heating up to 10-13°C (50-55°F) with thermostatically controlled convectors to give comfort conditions for occupied periods.

Thermal treatment of the building and floor slab becomes very important and also selection of floor finish. Certain timbers are recommended for wood floors, but these must be specially kiln dried. Useful advice can be obtained on this from the Timber Development Association.

Where the use of off peak storage heaters is considered, these must be of the controlled output type which are, of course, more expensive than the normal domestic pattern.

Where such installations are small compared with the main load of the hospital there is no advantage in adopting the Supply Authorities off-peak tariff as it will generally be found that with a sliding block tariff the unit charge is lower than the off-peak and it is only necessary to control the heating load so that it does not increase the normal maximum demand.

Laundries

The modern trend is to provide large central laundries capable of laundering over 100,000 pieces per week and serving a group of hospitals. Modern machinery is supplied by manufacturers either as single unit or, particularly in the case of washing machines, a series of machines operating in automatic sequence and having automatic control units. Interconnecting wiring is carried out by the manufacturers who also instal the complete equipment. Supplies will be needed, to be brought to agreed positions for the various machines. Wiring should be in M.I.C.C. cable, terminating in isolators adjacent to the machine.

Laundries are governed by the Factories Act and Emergency stop buttons should be provided in accordance with the requirements of the Act.

As a guide when assessing loads, initially, a recently completed laundry with modern machinery and processing 100,000 pieces per week had a maximum demand of 1·5 kVA per 1,000 pieces.

Ventilation requirements will be fairly high and this is usually provided by a number of individual units for which power supplies will be needed.

Medical Gases

Central supplies of Medical Gases will be provided from bulk supply points. Nitrous Oxide (N_2O) will be stored in banks of cylinders arranged for automatic stand-by operation. Electrical supplies are required for the functioning of these units and warning lights will be needed, wired back to central points.

Oxygen may be supplied by the same method but, if demands exceed 10,000 cu. ft./week, liquid oxygen plant may be installed. In addition to warning lights, a supply of about 40A 3 phase will be required, terminating in a 60A Reyrolle socket (provided by B.O.C.) for use by the road tanker.

Incinerators

Although the present tendency is to provide large gas or oil-fired central incinerators to which all waste is taken in bags, there is still a demand for some local units. These may be small units for sanitary purposes or larger units for dressings. If of the electric type, they should be fan assisted.

Consideration should be given to the use of sanitary units which comprise a plastic bag in an enclosure which provides automatic sealing by heat when the bag is full. This is then removed for disposal in the main incinerator or elsewhere.

Power Factor Correction and Limiting of M.D.

The greatest field for P.F. correction is almost certain to be the Laundry where a substantial load of 150 to 200 H.P. will exist, made up largely of small motors.

Automatic correction will be expensive and it is probable that if this were provided a case could be made for its use on the whole hospital system. Alternatively, each motor can be equipped with its own individual correction, but again this is expensive compared with block correction which can be switched in all the time the Laundry is in use. It is most unlikely that there will be a large enough motor in the hospital which is continuously in use and can be used for correction purposes if of the synchronous type.

The limitation of maximum demand is more difficult to achieve in a hospital than in a commercial or factory building, where it is possible to set down a rigid programme of processes in such a way as to keep the maximum demand to a minimum without interfering with production. This control is not possible in a hospital, but nevertheless it is possible to apply it in some aspects. If we take the case of a water supply pump which is run under control of a level device in the main tank, it is most unlikely that it will be called to run continuously, and the high level tanks should have a capacity equal to $\frac{1}{4}$ of the daily demand. The electrical maximum demand is measured by summation over half hour periods and it is quite a simple matter to use a time switch in the motor control circuit so that, should the motor be called upon to run for say $\frac{1}{2}$ hour in each hour, this period will be spread over 2–$\frac{1}{2}$ hour periods of the M.D. meter, thus halving the recorded demand. Even if the motor is required to run for say 40 minutes in each hour the period can be adjusted to be 20 mins. in each half hour metering period, so reducing the M.D. to $\frac{2}{3}$. The high level control will, of course, override the time switch and a low level alarm should be fitted below the normal low level control.

Fire pumps should always be tested at off peak periods, i.e. when the Laundry or other large load is shut down. Many such expedients will suggest themselves if a little thought is given to the problem.

Emergency Supplies (Battery)

Emergency lighting supplies should be provided for Operating Theatres, Casualty Theatres and Maternity Delivery Units where it is essential that lighting be interrupted for the minimum possible period in the event of mains failure.

The supply voltage should generally be 25, 50 or 100 depending on the size of the installation. Lead acid or nickel-cadmium cells may be used. Nickel-cadmium cells have the advantage that they will stand for long periods unused and still maintain their charge. They do not evolve gasses and do not therefore need specially ventilated enclosures. On the other hand lead acid batteries have been found to give excellent service over long periods, given adequate maintenance. Automatic trickle chargers will be needed in each case and the capacity should be sufficient to provide 3 hours full load for normal situations but up to 5 hours for Neurological Theatres.

Care must be taken with nickel-cadmium cells to ensure that at no time do they become completely discharged as serious loss of capacity may ensue on subsequent re-charge.

Wiring throughout must be completely independent of mains wiring and, apart from the Surgeon's lamp, separate fittings should be supplied for emergency purposes in order to make the two systems completely independent. In the case of multi lamp surgeons lights, the emergency supply will energise the same lamps as the mains which will be fed through a transformer so that the A.C. voltage is the same as the D.C. With single lamp units the emergency supply will energise separate lamps. General emergency lighting will be required in Theatres, Anaesthetic Rooms, Sterilizer Rooms and Recovery Rooms, but this need not be of the same standard of illumination as the mains service.

With the scialytic fitting having one mains lamp only the control should be by means of a series relay which will bring the emergency lamps in the fitting into use immediately current ceases to flow through the main lamp, thus providing protection against mains failure, whether local or general, and also lamp failure. A separate relay should be provided to energise the general emergency lighting in the event of failure of the supply to the bus-bars of the distribution board feeding the general lighting. In all cases the emergency supply should be controlled so that in the event of a failure occurring when the mains lighting is not in use, the emergency lighting will not be energised, causing unnecessary discharge of the battery. This can be accomplished by providing a second pole on all switches and connecting those in one room or area in parallel so that in the event of any or all switches being ON the emergency lighting will come on but if they are all off then it will not.

All cables connected to the battery supply should be colour coded for easy identification.

Battery stand-by should be provided, even when diesel emergency supply is available, but in this case it need only supply the operating lamp and of capacity to maintain this for ½ hour.

The use of a maintained system of battery supply where the normal supply is obtained from a rectifier with the battery floating across this supply does not provide safeguard against local wiring failures.

Diesel Emergency Supplies

A diesel alternator should be provided capable of maintaining supplies as set out in Technical Memorandum No. 11.

The unit should preferably be housed in the Boiler House where constant attendance is normally available. The capacity may well amount to 50% of the maximum demand, but, owing to the short running periods which can be anticipated, the provision of heat recovery is not justified.

The whole installation of the hospital will need to be divided into "essential" and "non-essential" services and this can either be done locally or at the main supply point. The cast of cabling will not vary materially with either system but if the division is made at the central point a fault in the cable supplying the essential load will prevent the use of diesel supply. If the division is made at the blocks, separate main and diesel supply cables will be required and a change-over relay will be needed at each point.

The method of starting the diesel unit must be determined by site conditions, the alternatives being fully automatic or manual. The following remarks may be helpful in reaching a decision:—

Automatic Starting

This is accomplished by having 3 voltage sensitive relays (1 per phase), the failure of any one causing the engine to start and pick up load. If these relays are connected to the bus-bars of the main switch-board they will protect against failure of the incoming supply but will not provide for local failures of the cables or main fuses. In order to provide against this it will be necessary to provide additional relays at each block with pilot wiring back to the main starting panel.

It should be so arranged that the supply from the diesel is only used at the affected blocks, the remainder being supplied from the mains. Provision should be made at each block so that, in the event of a prolonged failure to any one block, temporary connections can be made to energise the whole installation in that block, thus making full use of the supply available.

Manual Starting

Manual starting may be called for by two main methods.

(1) Automatic alarm system whereby the main switch fuse in each block concerned is replaced by a circuit breaker fitted with no volt and over current releases and back contacts. On tripping, the back

contacts will energise an alarm circuit at the main control point and also the appropriate way on an indicator. On receipt of the alarm, the attendant will start the diesel and report to the Engineer for investigation of the fault.

(2) By use of the internal telephone system. A responsible person at each vital point will telephone the attendant to report the failure, but this can lead to delays and confusion when a general failure occurs.

Arrangements suggested for various situations are as follows:—

As the Boiler House will contain a number of boilers not all of which will be in use at one time, and of those in use not all will be fired in the case of emergency, the automatic connection to the emergency supply becomes too complicated. In the event of failure of supply, all boilers on line should shut down, for which purpose push-button contactors should be provided for all items of equipment, i.e. fans, pumps, heaters, etc. When the diesel supply is available it should energise the complete main panel together with emergency lighting and the attendant will then re-establish supplies to the equipment necessary to bring the appropriate boilers required into operation. In the case of automatic starting of the diesel, the emergency lighting should come in without switching by the attendant but, in the case of manual starting, battery operated lamps which will light on mains failure should be provided at strategic points to enable the attendant to reach the set and start it up.

(Concluded)

Système International d'Unités (SI)

SI is the abbreviation by which the Système International d Unités (International System of Units) is known in any language. It may be regarded as a development of the MKS (metre, kilogramme, second) system of units which has been used for decades by electrotechnologists and which grew into the MKSA (metre, kilogramme, second, ampère) system of Professor Giorgi.

In 1960 the General Conference of Weights and Measures, a world body of which the UK is a member, recommended that SI should be taken into use instead of existing metric systems. In 1962 both the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC) endorsed that recommendation. Since then some 23 countries, including the major industrial ones, have declared their intentions of making SI the only legally acceptable system, and 12 of them have already been as good as their word and have put the relevant laws on their Statute Books.

It is quite clear that since a metric system is at present used by 90% of the world's population, and bids fair to spread to 100%, and since the principal metric countries have agreed to adopt SI, then SI will in a matter of years be the system used throughout the world. This is why British industry, through the Industry Standards Committees of BSI, has opted to go straight to the use of SI in changing to a metric system of measurement for this country.

It is worth noting that the decision must have been the same even if SI could be shown to be of indifferent intrinsic merit. The overwhelming reason for our choice of SI is its promised universality.

Paper given at a symposium *Preparing for metrication*, organised by the Production Engineering Research Association of Great Britain (PERA). Published by permission of *BSI News*.

What is SI?

The reason for the ready universal adoption of SI is that it is incomparably simpler that the present metric system or the imperial system.

It has as its basis a rationalized selection of present metric units, and from only six basic units derives, coherently, units for all other quantities required. The six basic units are:

Length	—	the metre (m)
Mass	—	the kilogramme (kg)
Time	—	the second (s)
Electric current		the ampere (A)
Luminous intensity	—	the candela (cd)
Temperature		the kelvin (K)

When we say a system is coherent we mean that the product or quotient of two or more of its units is the unit of the resultant quantity. Thus the coherent unit of velocity is the metre per second (m/s) *not* the kilometre per hour (km/h). Similarly the coherent unit of force is that force which imparts to unit mass an acceleration of one metre per second squared. Thus this unit of force, which has been called the newton (N), is the kg m/s^2. This is a most important unit, in that it is an ingredient of many of the units which are commonly used in engineering, such as pressure, stress, energy and power.

Force

We shall see how coherence in a system of units considerably simplifies computations, and is thus a quality which is well worth preserving. For this reason alone one should work with the coherent unit of force, the newton, as opposed to the non-coherent unit of force, the kilogramme-force (kgf). This latter is defined as that force which, applied to a mass of one kilogramme, produces in it an acceleration equal to standard gravitational acceleration ($9{\cdot}80665\ m/s^2$).

Quite apart from the need to use the newton to preserve the coherence of the system it is, indeed, a much more logical unit to use for its own sake, particularly in calculations in dynamics. It is probably no exaggeration to say that at least 90% of us never quite knew the real significance of g in our equations in dynamics. This is hardly surprising, since because we worked with gravitational units of force (lbf or tonf) which, in effect, had a "built-in" g, we had the anomalous and confusing situation that if our problem concerned masses moving under the influence of gravity then g did not appear in our equations; whereas if our problem was in no way influenced by gravity, then a g had to appear somewhere to cancel the "built-in" g in our force unit.

Most of us who are honest will admit that in these circumstances we often arrived at answers which were obviously 32·2 or $32{\cdot}2^2$ times too big or small, so we went back through our working to find where g had been omitted or put in the wrong place. If only we had been taught to remember P (poundals) = W (lb) a (ft/s^2) instead of $P\ (lb) = \dfrac{W\ (lb)\ a\ (ft/s^2)}{g\ (ft/s^2)}$ life would really have been so much simpler. And if you are saying to yourself that at long last you really know what it is all about and do not want to change a lifetime's habit, do give a thought to the rising generation and do not begrudge them the simplicity you were denied. In any case, don't deny yourself the great advantages offered by a coherent system of units, which you would do if you clung to gravitational force units.

Non-coherence of existing systems

It would be very easy, with hindsight, to poke fun at our traditional systems of units. When Watt invented his steam engine it replaced the horse so it was perfectly natural that his customers should want to know of its capability in terms of the horse. Hence the work rate of a dray horse was measured and called the horse-power, which had the non-coherent relation to the basic units of a foot, pound, second system—550 ft lb/s = 1 horse power, so all calculations are beset with the arbitrary conversion factor 550. It seems a pity, too, that the French seem to have used a slightly less powerful animal in their evaluation of the "cheval vapeur."

At the time when it was thought desirable to establish a unit of heat it was presumably the case that the effect of heat on water was something it was often necessary to predict. So it was logical that a unit was developed which was the amount of heat required to raise the temperature of unit mass of water by one degree of temperature. Hence the British thermal unit in the imperial system, and the calorie in the metric system, both of which, when mechanical equivalents of heat were evaluated, were seen to have quite arbitrary relations to the basic units of the two systems, e.g. 778 ft lb/Btu.

SI brooks none of this and lays down in effect that energy, be it thermal, electrical or mechanical, is basically the product of force and distance. Hence in SI the one and only unit of energy (or work) is the newton metre (N m), which has been named the joule. Similarly, whatever form power takes it is a rate of generation or dissipation of energy, so the one and only unit of power is the newton metre per second, or joule per second which is called the watt

$$1\,\frac{Nm}{s} = 1\,\frac{J}{s} = 1W.$$

"Sizes" of units

The choice of the metre and the kilogramme as basic units of length and mass, as opposed to the centimetre and gramme of present metric systems, gives coherently derived units of more practical values in many cases, but, even so, not all the coherent units are of a convenient size for all applications. The metre, for instance, is a convenient unit for such things as site plans, but is too large for precision engineering purposes and too small for the expression of large distances between towns. Provision is thus made for multiples and sub-multiples of the coherent units, and the total list of such factors is given in Table 1.

Thus for precision engineering drawing the usual unit for dimensions will be the millimetre, while distance between towns will be measured in kilometres.

Practical application of SI units

An ISO committee has published a draft recommendation concerning the use of SI units, and has, in general, observed two very important and practical principles:

(1) That any unit which is already internationally recognized and used shall not be lightly discarded even though the unit in question be a non-SI unit or a non-preferred multiple of an SI unit.

(2) To facilitate international communication, the number of 'preferred' multiples and sub-multiples for any particular unit should be restricted, so that in any particular application the probability of all concerned using the same multiple or sub-multiple would be great. The preference was expressed for multiples or sub-multiples separated by the factor 1000, i.e. of the form $10^{\pm 3n}$ where n is an integer. It follows that deca (10^1), hecto (10^2), deci (10^{-1}) and centi (10^{-2}) are non-preferred.

From these two rules come a number of important decisions. The internationally accepted time units, namely the minute, hour, day, week, month and year, will continue in use. The division of the circle into 360 degrees and the subdivisions of the degree, the minute and second will also continue for trigonometrical purposes. The supplementary SI unit, the radian, will, however, figure in dynamics problems as at present.

Further rules which are prescribed

The fact that double prefixes are not allowed brings out the unfortunate anomaly of having, as the basic unit of mass in SI, a multiple of the basic unit of the cgs system, because since double prefixes are not allowed then any multiple or sub-multiple of the kilogramme must inevitably be a different multiple or sub-multiple of the gramme. Thus 1000 kg (or 1 metric ton, or 1 tonne or 1t) may only be written as 1 Mg, while one millionth of a kilogramme is written as 1 mg.

TABLE 1
Multiples and sub-multiples of coherent units

Multiplication factor		Prefix	Symbol
1 000 000 000 000	10^{12}	tera	T
1 000 000 000	10^{9}	giga	G
1 000 000	10^{6}	mega	M
1 000	10^{3}	kilo	k
100	10^{2}	hecto	h
10	10^{1}	deca	da
0·1	10^{-1}	deci	d
0·01	10^{-2}	centi	c
0·001	10^{-3}	milli	m
0·000 001	10^{-6}	micro	
0·000 000 001	10^{-9}	nano	n
0·000 000 000 001	10^{-12}	pico	p
0·000 000 000 000 001	10^{-15}	femto	f
0·000 000 000 000 000 001	10^{-18}	atto	a

It is also recommended that if it is desired to modify the size of a unit which is a quotient, then the requisite prefix should be applied only to the numerator of the fraction. For example, the N/m² as a unit of pressure or stress is very small. More convenient values should be obtained by using kN/m² (×1000) or MN/m² (×1 000 000) rather than by using N/cm² (×10 000) or N/mm² (×1 000 000).*

BSI booklet

By canvassing opinion among some 50 member countries, ISO has established, for each common SI unit, the multiples and sub-multiples which will be in common use. With very few exceptions the present edition of the BSI booklet PD 5686 *The use of SI units* reflects these international agreements, and the booklet will shortly appear in a new edition which will include the latest international agreements.

There is an important area in which the rule of separating multiples by the factor 1000 will not be able to be applied in quite the same way. Although no firm pronouncement on this particular aspect has been made by the ISO committee, a deviation from the rule is clearly necessary.

The difference arises in respect of derived units which are powers of the basic units. Examples are m² for area, m³ for volume and m⁴ for second moment of area. It is important to remember that when a multiplying or dividing prefix is applied to a unit which is raised to a power, the prefix itself is also raised to the same power. For example:

$cm^2 = (cm)^2 = 10^{-4}m^2$ NOT $10^{-2}m^2$

$km^2 = (km)^2 = 10^{6}m^2$ NOT $10^{3}m^2$

Thus for areas between 1000 and 1 000 000 square metres, the dam² = 100m² (called the 'are') or the hm² = 10 000 m² (called the 'hectare') will be used, with a preference for the hectare.

Similarly, second moments of area of, say, steel beams, would involve astronomical figures if expressed in mm⁴ or microscopic figures if expressed in m⁴, so it is probable that cm⁴ will be used in that field.

Note: It is probable, however, that the N/mm² will often be used to express the strength of materials; the probable use of the hectobar (10^7 N/m²) and the bar (10^5 N/m²) to express stress and pressure should also be noted.

Formation of SI units

This is child's play if the rules are observed. All that is needed is a knowledge of first principles; provided units are made up which embody only the basic units or coherently derived units, the correct SI unit must emerge. Thus moment of force or torque is the coherently derived unit of force × the basic unit of length, i.e. the N m. Or, momentum is the product of mass and velocity, i.e. $\frac{\text{kg. m}}{\text{s}}$. It is thus unnecessary to recite all the units in common use, but they are all to be found in PD 5686.

Value of coherence

We have seen how coherence gives simple relationships between units rather than arbitrary conversion factors. The immense value of this in computation is best demonstrated by examples worked in imperial and in SI units.

Example 1

A pump delivers *z* gal/min of water against a pressure of *y* ft head. Ignoring the efficiencies of pump and motor, calculate the motor input.

In the imperial system we must go through power requirements in hp and use a conversion factor to obtain the watts input. We thus require to express the work done on the water in ft lb/s and then convert to hp and so on.

$$z \text{ gal/min} = \frac{10}{60} z \text{ lb/s}$$

$$\text{Thus power} = \frac{10}{60} \times zy \text{ ft lb/s}$$

$$= \frac{10\ zy}{60 \times 550} \text{hp}$$

$$= \frac{746 \times 10}{60 \times 550} zy \text{ watts}$$

Thus in this very simple calculation no less than four arbitrary conversion factors are used.

Working in SI units the discharge of the pump would be p m³/s while the pressure against which the flow is maintained would be q N/m².

$$\text{Power required} = p \text{ m}^3/\text{s} \times q \text{ N/m}^2$$

$$= pq\frac{\text{Nm}}{\text{s}} = pq\frac{\text{J}}{\text{s}} = pq \text{ watts}$$

No conversion factors—far simpler!!

It has been reliably estimated that computations in SI units will be six times shorter and six times quicker than in imperial units. It would be a fair further deduction that such calculations would also be much less prone to error.

Example 2

A lift of mass 2 tons is required to be accelerated upward at 16 ft/s². Neglecting friction, what starting torque is required if the cable drum is 3 ft diameter?

Force required to overcome gravity = 2 tonf.

Force required to accelerate lift

$$= \frac{2 \times 16}{32 \cdot 2} = 0 \cdot 99 \text{ tonf}$$

Total force $= 2{\cdot}99$ tonf

$$\text{Starting torque} = \frac{2{\cdot}99 \times 3}{2}$$

$= 45$ tonf ft approx.

Note that g does *not* appear in that component of the force required to overcome gravity, but it *does* appear in that component required to accelerate the mass. This is the anomaly of the gravitational force unit.

A lift mass 2 tonnes is to be accelerated upward at 5 m/s^2. Neglecting friction, what starting torque is required if the cable drum is 1 m diameter?

The rope pull is required to overcome gravity, and to accelerate the lift upward.

Thus pull required is $(2 \times 1000 \times 9{\cdot}81)$
$+ (2 \times 1000 \times 5)$ N$=29{\cdot}62$ kN (approz. 3 tonf)

Starting torque required $= 29{\cdot}62 \times 0{\cdot}5$ kNm
$= 14{\cdot}81$ kNm
(approx. $4{\cdot}5$ tonf ft)

Note here that g ($9{\cdot}81$ m/s^2) appears only in that component of the force required to overcome gravity.

Example 3

An electrical generator is to supply $3{\cdot}2$ MW. Its efficiency is 88%. What horsepower is required to drive it? The driving engine has an overall efficiency of 30%, and uses fuel with a calorific value of 18 000 Btu per lb. What is its rate of fuel consumption, in lb/h?

Power required is $\frac{3{\cdot}2}{0{\cdot}88}$ MW, or $3{\cdot}64$ MW

hp required is $3{\cdot}64 \times 1340$, or 4380 hp

Power from the fuel will be $\frac{4380 \times 100}{30}$ or 14900 hp

$= 14900 \times 550$ ft lb/s

1 Btu is 778 ft lb (mechanical equivalent of heat)

The heat consumption is therefore

$$\frac{14900 \times 500}{778} \text{ Btu/s}$$

The fuel consumption is therefore

$$\frac{14900 \times 550}{778 \times 18000} \text{ lb/s, or } 0{\cdot}64 \text{ lb/s}$$

or $0{\cdot}64 \times 3600$ lb/h, or 2300 lb/h.

SI units

An electrical generator is to supply $3{\cdot}2$ MW. Its efficiency is 88%. How many MW are required to drive it? The driving engine has an overall efficiency of 30%, and uses fuel with a calorific value of 42 MJ/kg. What is its fuel consumption in kg/h?

The power required is $\frac{3{\cdot}2}{0{\cdot}88}$ MW, or $3{\cdot}64$ MW

Power from the fuel will be $\frac{3{\cdot}64 \times 100}{30}$ MW,

or $12{\cdot}1$ MW, or $12{\cdot}1$ MJ/s

Therefore the fuel consumption is $\frac{12{\cdot}1}{42}$ kg/s,

or 0.289 kg/s

or $0{\cdot}289 \times 3600$ kg/h, or 1040 kg/h.

The SI uses the same units for electrical output, engine power and calorific requirements per second. It compares like with like. Traditional units do not recognize this. An engine is not a generator, is not fuel, so they can't have the same units, so the thought runs. It was Joule who found the common thread, which can save needless conversions.

Transition

It is worth remembering that, just as we shall take a few years to effect the change from the imperial system, so the present metric countries will need a few years to effect the change to SI from their currently familiar metric systems. For this reason, in BSI, we are basing our metric British Standards on SI units, but shall also show equivalents, where desirable, in currently familiar metric units for the next few years. For example, if stress is expressed in some multiple of the N/m^2, it may also be shown in kgf/mm^2 or kP/mm^2.

MARCONI TELEVISION FOR SHEFFIELD HOSPITAL

The Marconi Company has recently installed and commissioned a £4,000 closed-circuit television system for the University Department of Obstetrics and Gynaecology and for the Jessop Hospital for Women, Sheffield. The system is used to facilitate undergraduate, postgraduate, nursing and midwifery training, and to improve the quality of care offered to patients.

The television camera, with a video tape recorder and its own monitor, has been so housed as to be fully mobile, so that the system can be used wherever electrical power is available. In addition, the five labour wards, two operating theatres and lecture theatre projection room are all linked by a vision, sound and talk-back system so that recorded or live programmes can be shown in the lecture theatre.

The camera used in the system, the Marconi V322B, has been designed specifically to meet the needs of educational closed circuit television. It is, however, equally suitable for many small studio applications, and for a variety of other closed-circuit requirements. For the Jessop Hospital application the camera is fitted with a tripod and a 4–1 zoom lens.

OSMA SLASH PRICES

Osma Plastics Ltd., the largest suppliers of plastics plumbing products to the building industry, have made substantial price reductions in their rainwater, soil, overflow and waste systems. Waste and overflow pipework, for example, has been slashed by over 22%.

The new price structure will come into effect in December, 1968.

GOODMAN PRICE DEMOLISHES ST. THOMAS' HOSPITAL

The northern half of St. Thomas' Hospital is currently being demolished by Goodman Price Ltd. to make way for the second stage in the rebuilding.

The three elements of the rebuilding programme are the East Wing, the 11-storey ward block opened in the summer of 1966; immediately in front of it is part of the southern half of the old hospital which will remain in service for about another eight years; and the area on which will be built during that time a 13-storey ward block, a 5-storey treatment block, and a residential and training school block for nurses.

DUNDEE DENTAL HOSPITAL AND SCHOOL

Opening by the Queen Mother

H.M. Queen Elizabeth the Queen Mother, who is Chancellor of the University of Dundee and Patron of the Dental Hospital, opened the Dundee Hospital and School on October 17th. It is the first unit of its kind to have been opened in Scotland for 14 years. A blend of the old, incorporating the original buildings and the new, it provides Dundee with the most modern facilities possible for the treatment of patients and the education of dental students.

The idea of erecting a new hospital and school had obvious attractions; but this would have entailed a search for a site possibly remote from the University campus and from the centre of population and the sacrifice of much which was reasonably modern in capital building. For these reasons the idea of transferring, perhaps to the site of the new teaching hospital and medical school being built at Ninewalls, Dundee, was rejected.

Work on the new building began in 1962 and the tower block was completed last year. Since then the physical reconstruction and integration of the old and the new has been taking place.

In the clinical area of the extended Dental Hospital are 115 dental chairs, and the intake of undergraduate students is intended to be 50 per annum with 10 to 15 postgraduates. The total cost of the building and equipment was £900,000.

Layout

The building is T-shaped in plan, the "arms" being provided by the renovated Dental Hospital and School buildings, three-storeys high, and the "leg" is the linking tower block which has 10 floors.

Provision had to be made for several streams of traffic. While there was no social reason for separating them, congestion can easily occur. This may create a "busy" appearance but the chances were that efficiency would be impeded. To a dental hospital come patients and relatives; staff (professional, technical, nursing, administrative and clerical); and students of both sexes. In addition there must be separate channels for the receipt and distribution of a variety of stores and linen; the delivery and movement of equipment within the building had to be considered as did the disposal of waste with the minimum possibility of spillage *en route;* and there was the question of the reception of heavy cylinders without damage to the building.

To meet the needs of patients and staff there are car parks at the front and rear, but for each category there are separate entrances to the building. For patients travelling by ambulance and vehicles carrying supplies there is a covered area in the tower block. From this area are five separate entrances into the building.

1. To patients' entrance hall with a ramp up which a patient can be conveyed either by wheelchair or trolley.
2. To students' locker and common room with easy delivery of supplies to the kitchen near the door.
3. Academic entrance.
4. Plant room in which are situated not only calorifiers and the large air compressors, but also connecting points for gas cylinders near the door so that carriage of them through the building is minimal.
5. Electrical sub-station in which high tension current from the grid is stepped down to supply the whole complex.

Services

Drainage, hot and cold water, steam, electricity, compressed air, waste disposal and document delivery are important vital services in a modern dental hospital and school and these have been provided in a vertical duct system along the length of the tower building. This not only ensures easy access for servicing, but also means shorter lengths of near horizontal drains with the possibility of steeper falls.

Two vertical waste chutes for old plaster, etc., are situated at the west end of the tower, and plaster benches in laboratories on the third, fourth and fifth floors are based upon them. The chutes descend into bins in a special room near the door from which easy removal to the Corporation refuse lorries can be achieved. The waste chutes in the old hospital and school have also been retained.

Steam is provided from the University boiler house to the Plant Room and serves not only the central heating system which, in the tower building, is located in the ceilings, but also for the autoclaves in the clinical departments.

The problem presented by the delivery of a large variety of sterilised instruments to the chairs in the five clinical floors was a factor in the rejection of central sterilisation for the whole hospital complex. Separate sterilising rooms with autoclaves placed centrally in each department with different means of delivery according to departments has been preferred.

Features of the Hospital

Lower Ground Floor. This is present only in the old hospital building and contains the Engineer's workshop and office, sister's room, common and locker rooms for Dental Surgery Assistants, Locker rooms for technicians and some storage facilities. A special parcels entrance is provided with a lift for linen and other stores to convey them to the ground floor.

Ground Floor. The patients' entrance hall on the ground floor has a kiosk in which the telephone exchange is situated. This entrance hall is carpeted in an attempt to reduce the transmission of dirt from the street to the clinical areas.

The staff entrance (old hospital entrance) gives access to common and locker rooms for both professional and technician staff and also to the Steward's store and linen room.

The students' entrance leads to the students' locker rooms and common room and also an instrument development workshop.

First Floor. Here is found the main waiting hall at the east end with a spacious reception office in which patients' records are stored. From it an automatic document elevator ascends to all clinical floors. Behind the reception office is the main hospital office, in which is situated the telephone central dictation apparatus operated by a typist pool.

Opposite the reception office, the diagnostic area is to be found consisting of a main room with eight chairs and the radiographic facilities closely integrated with the areas for clinical examination. Separate rooms for waiting, sterilising, clinical photography, consultant clinics and automatic film processing are provided.

Extending westwards from the main waiting hall is the oral surgery department with separate rooms for extractions under local anaesthesia, anaesthetic theatre, demonstration surgery, sterilising and staff rooms.

Behind the hospital office facilities in the old school are situated the clinical pathological museum and the facilities for academic administration.

Second Floor. On this floor is to be found the Conservation Department which forms a large "L" in plan, one limb of which is the old department modernised, whereas the other is completely new situated in the tower component. There are 40 chairs and units in the open areas and nine in separate surgeries. Two sterilising rooms, a Senior Lecturer's room, a production laboratory, a darkroom and waiting areas are also provided.

In the old school two teaching prosthetic laboratories are to be found and also in the retiring rooms for the Professor of Dental Health and Lecturers in Dental Prosthetics.

Third Floor. The Periodontal Department is the clinical area on this floor and contains not only a main clinic but also sterilising, Senior Lecturer's Demonstration and waiting rooms.

There is also an Operative Technique Laboratory in which students can construct crowns, bridges and inlays for patients as well as practice restorations on the phantom head.

Fourth Floor. This floor is mainly devoted to Prosthetic Dentistry containing a large clinic area, retiring rooms for the Professor and Senior Lecturer, demonstration surgery, waiting area and production prosthetic laboratory. The Regional Consultant Orthodontist has a surgery and an office on this floor.

Fifth Floor. The dental care of children is the function of this floor—it being divided into two closely integrated parts. One is concerned with their general dental care and children under 13 years of age come directly to this area for initial diagnosis and preventive or conservative care. There is both a demonstration surgery and a room for the Senior Lecturer. The other part is devoted to Orthodontics and consists in addition to the main clinic area, of a Senior Lecturer's room, separate surgeries, model storage room and a production orthodontic laboratory.

The waiting area, sterilising room and seminar room are shared by the two parts of the combined Department.

Sixth Floor. This is the lowest academic floor and in common with the higher floors is served only by the two academic lifts on the west side of the tower, though access is also provided by both staircases.

Apart from a Board Room this floor is devoted to formal teaching with two lecture rooms separated by a common projection room. The larger lecture room provides for 164 and the smaller for 56 students. There is also a demonstration and a seminar room.

Automatic projection, blind and light controls are provided in both lecture rooms and screens for closed circuit television the input of which can be from any demonstration surgery or room.

Seventh Floor. Here we have the teaching laboratory for both dental anatomy and histology and patho-histology for 50 students. There is a demonstration/museum for dental anatomy, a retiring room for the Reader and research laboratories for investigation of normal dental structure. In addition, research rooms for dental materials, physical and chemical, are situated on this floor.

Eighth and Ninth Floors. Whilst individual rooms have been provided for Senior Lecturers and Professors, research rooms have been designed functionally rather than personally. On these floors separate rooms are devoted to electron microscopy, photography, photo micrography, x-ray tracing, patho histology and biochemistry. Each research worker is provided with at least nine feet of bench space at sitting height so that he has a built in desk and above a glazed book shelf and cupboard space. Basic bench design has been modified according to the specialised function of the research room.

On the eighth floor also there is a large hospital patho histological laboratory situated near the lift for the receipt, processing and reporting on biopsy and other specimens. The retiring rooms for both the Professor and Senior Lecturer in Dental Surgery are provided on this floor.

Lifts

There are two lifts from the patients' entrance hall to the waiting areas of the clinical departments situated one above the other in the first five floors of the tower, but the associated staircase ascends the whole height of the building. Two lifts ascend from the academic entrance with a staircase to all floors above the first. These lifts are not for patients' use. The two lifts opposite the staff and students' entrances have been retained to serve the reconditioned parts of the complex.

Conclusion

It is believed that in this extended complex attractive clinics with good facilities for all types of dentistry have been provided, whilst in the academic areas the modern needs of both dental education and research have been met.

Architect

The late H. P. Robbie succeeded by Martin T. Wellwood in collaboration with the late James Deuchars, Regional Architect.

Consultant Engineers

Ramsay and Primrose, Glasgow and Edinburgh, in collaboration with E. L. Taylor, Regional Engineer.

Contractor

Charles Gray (Builders) Ltd.

QUEEN OPENS KING'S COLLEGE HOSPITAL EXTENSION

ON WEDNESDAY, 23rd October, Her Majesty the Queen formally opened the new ten-storey ward block at London's famous King's College Hospital.

The £1,400,000 project has been completed by Y. J. Lovell (London) Ltd.

Distinctive features of the building outside include nylon-coated steel peristyles, slatted sunbreakers and perimeter beams faced with hammered granite aggregate.

Inside, the arrangement of the building is as follows. The basement houses most of the plant rooms, the main kitchen, workshops used by the hospital's engineering section, and is extended by underground corridor links to the older main hospital and a nurses home.

The ground floor contains a cobalt unit, special x-ray facilities, hot isotope laboratories, a caesium unit and staff rooms. Concrete walls 30 in. thick surround the cobalt unit and viewing panels are of the same thickness in optical glass.

Above this level, basic floor use pattern is: 1st floor, wards and ophthalmic theatre; 2nd floor, wards; 3rd floor, wards and diabetic section; 4th floor, maternity wards, baby care and mothers' facilities, laboratories; 5th, 6th floors, maternity wards, nurseries; 7th floor, nurseries and maternity facilities, delivery room, private patients' accommodation; 8th floor, delivery rooms, operating theatre, wards, x-ray department, training area, fathers' room; 9th floor, laboratories, common rooms, staff areas, plant rooms; 10th floor, plant and equipment, lift motors.

Architects of the project were George Trew Dunn and the quantity surveyors were Crump and Partners. Others involved were consulting engineers Ove Arup and Partners, mechanical consultants Dale and Benham and Barlow Leslie and Partners, electrical consultants.

Electronic Communications

A comprehensive electronic communications system and television and radio relay have been installed by British Relay.

The company's nurse-call communications installation comprises 8 sister control stations, 15 nurse control stations and patient calling positions in 162 bedhead locker units, 26 bathrooms and 55 toilets.

Each bedside locker throughout the new ward block is fitted with a remote-control panel carrying the controls for the nurse-call communications system, radio controls and a mains socket for specialised equipment. Each dayroom is equipped for television relay for all programmes including BBC-2 colour.

A special fitment plugged into the bedside panels allows seriously ill or inert patients to summon immediate assistance by means of gentle pressure on a hand-switch.

When the nursing staff answer a patient's call they indicate their presence at the bedside by pressing a special push-button switch which illuminates indicator lights in the corridor giving instant staff location facilities.

When a patient calls for assistance, the following coloured lights code indicates on the sister's or nurses' control station panels and in the corridors: a steady red light for a normal patient call, a yellow light to show that a nurse is present in the patient's room, a green light to indicate that a sister is present, a steady red and yellow light together means that a call has been made and a nurse is in attendance, a flashing red light indicates an urgent call by a patient or that a nurse requires assistance.

In addition to the lamp indicators, buzzers sound for one second at eight-second intervals for normal calls and at one-second intervals for emergency calls.

B.S.I. News

Abstracts of information supplied by the British Standards Institution

STEEL BOILER AND SUPERHEATER TUBES

A major revision of B.S. 3059 *Steel boiler and superheater tubes* (metric units) has recently been published.

Separated into two parts, this standard includes requirements both for carbon steel tubes without specified elevated temperature properties and for carbon alloy and austenitic steel tubes with specified elevated temperature properties.

Provisions are now included for the latter tubes to be supplied to alternative test requirements, designated Test Categories 1 and 2. Test Category 1 provides the mandatory ultrasonic non-destructive testing of the tubes, details of which are included in an appendix.

The standard covers electric resistance welded, hot finished seamless and cold finished seamless tubes, and includes in an appendix details of preferred outside diameters and thicknesses. This appendix aligns with Draft ISO Recommendation 1495 *Boiler tubes: dimensions, tolerances and conventional masses per unit length.*

Requirements are specified for chemical composition—including permissible deviations on product analysis; room temperature and elevated temperature mechanical properties; flattening; drift expanding; and hydraulic tests.

The standard also contains an appendix giving details of the stress rupture properties of the specified carbon, alloy, and austenitic stainless steels.

(B.S. 3059, price 15s.)

On the Market

A review of new equipment and materials and their development

NEW TESTERS AND CHARGERS FOR NICKEL-CADMIUM BATTERIES

A range of compact battery capacity testers and constant-current chargers has been introduced by **Richmond Electronics (Markyate) Ltd.,** Hicks Road, Markyate, Herts. The equipment is available through Cadmium Nickel Batteries Ltd., Park Royal Road, London, N.W.10.

Each is a portable unit which may be used free-standing or incorporated in a 19-in. standard rack.

The Type 2 tester can measure the capacity of batteries from 0-30V (nominal) with a discharge current of 0-50A. Battery discharge is at a controlled rate and a variable trip-level device automatically disconnects the battery at a predetermined voltage. A "test complete" lamp illuminates at this stage and, if required, an alarm can be caused to sound.

Battery capacity is indicated at the end of the discharge period on a four-digit counter. This directly gives a percentage one hour or ten hours, according to capacity rating.

The Type 3 tester is a smaller version of the Type 2 for users requiring equipment for batteries from 10-30V (nominal) with 10-25A discharge.

The three chargers have respective outputs of 10A, 20A and 30A, thyristor controlled to within an accuracy of ± 2 per cent. Charging time is indicated by a four-digit counter operating in increments of 0·1 minute.

All units are suitable for operation on 230V 50Hz or 115V 60Hz supply. When a tester is rack-mounted together with one or more chargers, a programmer can be supplied for automatic switchover from discharge to charge.

This equipment can be used for batteries installed in hospitals for emergency power.

NEW PROTECTION DEVICE FOR MOTOR DRIVEN MACHINES

The 30-98 Company Ltd. of Horley, Surrey has now developed a motor overload trip unit which operates virtually instantaneously, so giving maximum possible protection to any motor driven machine.

Known as the "Fastrip V", this instrument has been designed to provide protection for motor-driven machines which may become overloaded either through mechanical defect or the ingress of foreign matter. It may, of course, be used in some cases to supplement conventional overload devices where these give inadequate electrical protection under certain conditions.

The advantage "Fastrip V" has over all conventional trip units, slipping clutches and shear pins is that it can be set to absorb the usual excess current associated with starting with a fully adjustable range of from 1 to 30 seconds. This allows the trip point to be set to as little as 1% above the normal running current of the motor and the unit can be set to trip within 0·1 sec.

An additional feature is the "rate of rise" control which can be set to monitor the rate at which the current rises and trip immediately the permissible rate of rise is exceeded quite independently of the pre-set trip level.

The "Fastrip V" is manufactured in two versions, one for use with 22-28V AC/DC supply and the other with a tapped mains transformer for a 110 to 430V AC 50 Hz supply.

A 3 phase adaptor unit is also available which will ensure complete protection for all the three phases.

NEW DIFFERENTIAL PRESSURE REGULATOR

Danfoss (London) Ltd., 6 Wadsworth Road, Perivale, Middlesex, announce the introduction of their type AVD differential pressure regulator which may also be used as a flow limiter or constant flow regulator.

The type AVD is a self-contained automatic water valve with a proportioning action, operating on a change in differential pressure. When used as a differential pressure regulator, the AVD provides supplementary control for central, group and district heating systems which already incorporate Danfoss type RAV thermostatic radiator valves or Danfoss type FJVR return temperature limiters. When used as a flow limiter, the valve ensures that the maximum quantity of water permitted in a system zone is not exceeded, whilst its use as a constant flow regulator enables it to maintain a basic load in the system. In cold water systems, it can be used to good advantage in conjunction with the Danfoss type RAVA thermostatic two-way valve.

When delivered, the AVD is set up for direct action - reverse action being obtainable by exchanging the positions of the adjustment and diaphragm units (both units are secured by 4 screws). The two units may be removed when the regulator is installed without draining the system. Two air venting screws are fitted to the diaphragm housing. The connector for the impulse tube marked '+' must be connected to the upstream pressure, the connector marked '-' being connected to the downstream pressure.

The new valve has a maximum working pressure of 142 lb/in^2 (10kp/cm^2) and a maximum water temperature of 195°F (90°C).

Further details, including price and delivery, are available on request to the manufacturer.

AUTOMATIC LOW-LEVEL BETA COUNTER PROVIDES MEASUREMENT OF LOW-LEVEL BETA-RADIATING SAMPLES

The new Philips automatic low-level planchet beta counter is designed for use whenever it is necessary to measure the low-activity beta radiation of a large series of samples in medicine, biological work, and research in chemistry and biochemistry.

The instrument consists of all the equipment necessary for detection, automatic sample changing, compensation for background radiation, counting and digital recording.

Accurate measurement of low-level beta activity depends primarily on the reduction of background radiation - not only gamma radiation but also cosmic ray mesons which are affected very little by normal shielding. This instrument uses a measuring detector surrounded by a "guard" Geiger Müller tube designed specifically for use as a guard counter against cosmic radiation.

Every meson producing a pulse in the measuring tube triggers the guard tube as well. Only those pulses from the detector that are not coincident with the guard counter output are counted. Thus, in effect, background radiation is subtracted from the total radiation detected, leaving only the radiation from the sample to be measured.

All electronics are housed in standard 19-inch panels, providing a compact, self-contained arrangement. Modified versions, using G-M or scintillation detectors, are available. **N.V. Philips' Gloeilampenfabrieken,** Eindoven, the Netherlands (Industrial Equipment division).

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10 INCH DIAL TANK CONTENTS GAUGE

The **Eurogauge Co. Ltd.**, Imberhorne Lane, East Grinstead, Sussex, have introduced a new size of permanent reading tank contents gauge. To be known as the EG 250 Permanent, the gauge provides the same facilities as the EG 160 model, but for the fact that it has a 10 in. (254 mm.) dial instead of 6¼ in. (159 mm.). Both gauges are designed to operate with an air bell to give remote readings.

The EG 250 Permanent, which is suitable for surface mounting, is encased in a light alloy housing, and can be supplied with the 10 in. (254 mm.) dia. dial calibrated to suit customer's requirements. In its standard form the gauge can be used with storage vessels up to 20 ft. (6·1 m.) depth, or by using alternative equipment, up to 50 ft. (15·2 m.) depth. The standard air bell is suitable for remote readings up to a distance of 300 ft. (91·5 m.) from the storage vessel. Alternatively a special bell can be used for remote readings up to 500 ft. (152·5 m.).

NEW RANGE OF PIPELINE STRAINERS

Following the recent development and testing, production and distribution are now going forward at **Samuel Birkett** of their new range of Pipeline Strainers.

The Pipeline Strainers are designed to be equally effective with steam, water, oil, gas or air. They have self-aligning screens and a straining area several times that of the pipeline bore. They have ample clearance around the screens, and present the smallest possible resistance to flow. The standard screens of brass or stainless steel are extremely durable and can easily be removed for cleaning or replacement.

Available in gunmetal, cast iron and cast steel, Birkett Pipeline Strainers will withstand steam temperatures up to 650°F. and maximum working pressure up to 350 p.s.i.g.

The Birkett Pipeline Strainers come in eight sizes, ranging from ½" to 6", and usually can be supplied from stock. Further information from Samuel Birkett Ltd., Queen Street Works, Heckmondwike, Yorkshire.

NEW POCKET PAGING RECEIVER

A new mini Pocket Paging Receiver, which is now available with Cass Tele-Tracer wireless paging systems, is the smallest selective paging receiver available today.

Tele-Tracer systems enable individuals to receive an instantaneous call signal. Coded calls can be transmitted to indicate source or purpose of call. The new receiver, weighing less than 2½ ozs. and ½" thick, is designed to be carried loose in the pocket. A pocket clip is available.

Solid state and integrated circuitry is employed throughout the unit. The casing is of high impact plastic. The receiver can be powered either by dry batteries or by rechargeable accumulators.

For the rechargeable type of receiver, charging boards are available for 10, 30 and 50 receivers. Automatic indication is provided from the charging board to the telephone operator so as to indicate whether a person is in or out.

Further information from **Cass Electronics Ltd.**, White Hart Yard, Guildford Street, Chertsey, Surrey.

CHEMICAL DOSING PUMP

A new low output chemical dosing pump has just been introduced by **Richard Grosvenor & Co. Ltd.**, 53/54, Victoria Road, Surbiton, Surrey.

Developed from the "Pygme" boiler feed pump, it consists of a worm drive gearbox transmitting the reciprocating action to an all stainless steel pump end.

The pump has a 1" stroke and nine different plunger sizes giving outputs from 3½–60 g.p.h. Pressures up to approximately 1,000 p.s.i. are possible with motors from ⅛–½ h.p.

The separate valve units can be placed in any of five alternative positions to suit a particular installation. Each valve unit has a ball seating on renewable double "O" rings.

Alternative materials are available to handle a variety of aggressive liquids.

DAWSON-MMP WASHER FOR BABIES' FEEDING BOTTLES

At the new Maternity Unit of the Northgate Hospital at Great Yarmouth, the washing of the babies' feeding bottles is carried out automatically by a machine supplied by **Dawson Bros-MMP Ltd.** of Woodford Green in Essex.

The bottles are washed in special baskets. Three baskets at a time are loaded into the machine, each basket holding ten bottles. The baskets of bottles rest on a trolley which commences automatically to move so that the jetting impinges on every surface of the glass both internal and external. Because of the movement there is an adequate draining period between internal jettings which means that the bottles thoroughly drain during treatment. After the detergent wash there is a fresh hot water rinse which removes all traces of detergent and thoroughly freshens the insides and outsides of the bottles. By the time the detergent washing and rinsing processes are finished, which can take anything up to five minutes, a pilot light which has been on during this cycle goes out. Should the door be opened before the washing cycle is complete an automatic safety cut-out stops the machine. An Armourplate glass panel at the front gives full view and access to the interior of the machine.

NEW RANGE OF PNEUMATIC PRESSURE TRANSMITTERS

A new range of Pneumatic Pressure Transmitters, the 300T series from **Taylor Instrument Companies (Europe), Ltd.**, of Stevenage, Herts, have an absolute accuracy of $\pm 0{\cdot}5\%$. This range of transmitters will shortly be in production at the Taylor Stevenage factory, for delivery of the Differential Pressure versions by the end of this year.

The new 300T series are non-indicating force balance units transmitting a signal proportional to the differential produced by the primary element. The transmitters are ideal for use with industrial boilers to control flow of steam, feedwater, fuel, air, furnace pressure and boiler drum level.

Range limits from minus 800″ w.g. to plus 800″ w.g., spans from 5″ to 800″ w.g. and static pressures from 500–6,000 p.s.i.g. make the 300T a highly versatile and flexible series of instruments. The six instruments initially available cover high, medium and low ranges, which are 200–800″ w.g., 20–250″ w.g. and 5–50″ w.g. respectively. Repeatability is within $0{\cdot}1\%$.

The 300T series are designed to balance out changes in ambient conditions, and the accuracy of the instrument is not affected by changes in process temperature.

Further information, photographs or schematic diagram available on request.

FALKS CHAMPION BULKHEAD FITTING

A bulkhead fitting which can be surface or semi-recessed mounted has been produced by **Falks Ltd.**, 91 Farringdon Road, E.C.1. Called the "Champion", the body is non corrosive, being pressure die-cast from LM6M aluminium alloy; etch primed and finished externally in satin black stove enamel.

The clear prismatic glass cover has internal prisms to provide excellent light distribution. It is held in place by two recessed captive Philips-head screws, against a specially preformed neoprene gasket ensuring weather resistance.

The Champion has a recommended retail price of 30/-. It is equipped with a porcelain B.C. lampholder, to take a 60/100 watt lamp. Dimensions are 9″ long, 4½″ wide and 4½″ deep.

NEW X-RAY VIEWER

A new device for viewing x-rays has been developed by the **Colour Centre Ltd.** Known as the Idealite Model CC 1818, it has an illuminated screen 17½″ × 17½″: and other sizes are also available to take transparencies, either black-and-white, or colour, up to 2 ft. by 8 ft.

Its most important feature is that it provides cool, even illumination from a single fluorescent tube, diffused by a patented parabolic reflector. Little current is consumed and negligible heat is given off.

The Idealite Model CC 1818 has a comparatively narrow depth, and it will hang or stand. A stove-enamelled steel case encloses the unit. Various colours are available in flat or hammered finishes. It is also hoped to offer an all-plastic model in the near future.

Various voltages are available—210/240 and 110/125 AC or 6 and 12 DC.

Further information from The Colour Centre Ltd., Farnham Royal, Slough, Bucks.

UNIVERSAL RADIATORS LAUNCH "LINK-UP" PIPE

Universal Radiators Ltd., Argyll Works, 71, Priory Road, Hornsey, London, N.8, this month enter a new market to launch their new "Argyll Link-up"—a new range of interchangeable copper pipes.

The "Link-up" range consists of copper pipes, angles and bends, in seven different bore sizes, designed to enable complete plumbing systems to be specified on the drawing board for pre-fabrication at ground or site level. Each component fits into the next ready for brazing or soldering.

CORRESPONDENCE

14th October, 1968.

THE EDITOR,

Dear Sir,

I was interested to read Mr. A. C. Watson's article in your September issue dealing with the sound level of "emergency generating plant". Whilst in agreement with much of what Mr. Watson has to say, I think it should be pointed out to your readers that it is certainly possible to have diesel engined generating sets sound-proofed to quite low levels. In fact, to as low as 50 db.

The decibel readings of the units to which I refer are taken at a distance of only one metre from the generating set.

As the machine comes complete with its own built-in exhaust, air-intake and cooling, fuel tank and fuel control systems, and is completely housed in its own sound-proofed and weather protected cabinet, it is not necessary to use an acoustic building. In fact, it is not even necessary for the unit to be installed in a building at all.

The G. & M. Power Plant Co. Ltd., of Ipswich, have, for the past year, been supplying such equipment into the film and television industries, where perhaps, the problems are even more critical when noise levels are too high. The sets marketed by G. & M. Power Plant, whilst being totally enclosed for sound-proofing and weather protection, provide complete accessibility for maintenance purposes, as quite large sections of the outer cabinet can be opened in a matter of seconds, without the use of special tools.

It is possible to have mains failure equipment mounted either in the set or remote from it in cubicles or in a wall mounted form.

The price of silence is marginally more than Mr. Watson's graph, but as the G. & M. generators do not require acoustic buildings or expensive installations, the overall costs are, in fact, very much less.

Another important consideration is the fact that the G. & M. sets, being completely portable, relying upon no mains or fixed services, can be removed for re-siting at any time when redevelopment or reorganisation of hospital buildings becomes necessary.

Yours faithfully,

J. B. ROWELL,

G. & M. Power Plant Co., Ltd.

Brunton House, 19 Church Crescent,
Sproughton, Ipswich, Suffolk.

Notes for Members

OBITUARIES

D. A. Hughes

We regret to announce the death on 29th October, at home in Winchester, of Mr. David Arthur Hughes, C.B.E., C.Eng., F.I.Mech.E.

Mr. Hughes was lately Chief Engineer, the Ministry of Health. He was elected an Honorary Member of the Institute of Hospital Engineering on Friday, 29th May, 1964, at the 21st Anniversary Dinner in Cardiff, the organisation then functioning under its previous title.

A. M. Bain

We regret to announce the death on 30th August of Mr. Arthur Mechan Bain.

Mr. Bain served an apprenticeship with The British Electric Plant Co. Ltd., followed by two years with Walter Dixon & Co., Consulting Engineers. After three years at sea he was appointed Resident Engineer to the Orphan Homes of Scotland, Bridge of Weir in 1920. In 1941 he became Resident Engineer at Hairmyres Hospital, East Kilbride, being appointed Superintendent Engineer upon the formation of the Health Service. He remained in this post until his retirement.

Arthur Bain was elected a Member in 1944, and was a very active member who took a leading role in establishing the West of Scotland Branch of the Institute. He served as a member of Council for some fifteen years. In his private life he was an allround sportsman and was a particularly enthusiastic curler, a sport in which he excelled.

JOINT SCOTTISH BRANCHES CONFERENCES

The sixth Joint Scottish Branches Conferences was held at Gartloch Hospital, Gartcosh, Glasgow, from Thursday, 3rd, to Saturday, 5th October. Papers were given on Modern Trends in Hospital Sterilisers, Disposal Chutes, Reduction of Electricity Costs, and Gas goes to Hospitals on the first two days. The final session on the Saturday morning took the form of an Open Forum when three Administrators answered questions on administration problems.

It is intended to publish the papers given in the Journal.

The chairmen of the various sessions included A. Wotherspoon, Assistant Chief Engineer, Scottish Development Department; K. W. Wilson, Regional Engineer, Western Regional Hospital Board; A. Russell, Regional Engineer, South-East Regional Hospital Board; and C. Neil Anderson, Deputy Regional Engineer, Western Regional Hospital Board.

The whole conference was a great success, with average attendances of over fifty, which surely points to the high level of interest and keenness in Scotland. The organising committee is to be much congratulated. The accommodation made available at the Gartloch Hospital and, in particular, the catering facilities were of the highest standard.

The Secretary of the Institute and Mrs. Furness attended the Conference and were most grateful for the warm welcome and hospitality which they received.

WEST OF ENGLAND BRANCH

A meeting of the West of England Branch was held at Tone Vale Hospital, Taunton, on 13th July, 1968.

In opening the meeting, the Chairman welcomed J. Arnold and F. Hicks, of British Steam Specialties Ltd., Leicester, who had been invited to address members on the subject of the Angelery Hot Water Generator.

Mr. Arnold began by showing various examples of steam consumption, together with appropriate formulae, on the blackboard, and followed this with a number of slides. Mr. Hicks then took over and gave many instances of savings in steam and installation costs which could be effected by the use of the generator.

A discussion followed in the normal way.

LANCASHIRE BRANCH

On 28th September a Meeting of the Lancashire Branch took the form of a visit to the Fylde Water Board's Treatment Plant at Fishmoor near Blackburn. Members were conducted on a tour of the plant by W. B. Ramsay, Resident Engineer and Agent, and J. Williamson, Plant Foreman.

We have received a detailed description of the processing at Fishmore which lack of space prevents us from publishing in this issue. We intend to include the information, however, at a future date.

PERSONAL

K. C. Magee

Mr. K. C. Magee retired from the Service on 28th October as Group Engineer to Southend H.M.C. He received his technical education at the Municipal Technical College, Hull, and served an apprenticeship with Amos & Smith Ltd.; he subsequently obtained a 1st Class B.o.T. Certificate and was elected M.I.Mar.E.

After a varied engineering experience at sea and in industry, Mr. Magee became Engineer-in-Chief at Anlaby Road Hospital, Hull. Two years later he was appointed Chief Mechanical and Electrical Engineer for all the hospitals, sanatoria, etc., run under the County Borough of Southend-on-Sea. On Vesting Day, 1948, his responsibilities were transferred to the Health Service.

From 1948 to 1953 Mr. Magee was actively engaged on experimental work combating the hazards of static electricity in operating theatres, and much of this work was published in 1953. This was followed by experiments with the use of High Vacuum High Pressure Steam in hospital autoclaves and this was published in 1958 and referred to in the *Lancet* a year later.

Mr. Magee has actively supported London Branch activities since being elected a Member of the Institute, and is at present a member of the latter's Council. He was awarded the M.B.E. in the 1968 New Year's Honours List.

W. L. Williams

Mr. W. L. Williams began his career in the hospital world as a junior engineer at the Central Middlesex Hospital in 1921 and, after seven years, was appointed Assistant Engineer at St. Alfege's Hospital. In 1941 he obtained the post of Engineer-in-Charge at St. Giles Hospital, London, and, in 1948, was selected from a large number of applicants for the position of Group Engineer to the Southmead General Hospital H.M.C. During this period Mr. Williams was responsible for many minor capital schemes and made valuable contributions to the planning of major capital schemes.

In 1958 the Ham Green H.M.C. was added to the Group and Mr. Williams directed a crash improvement programme which enabled 250–300 beds to be opened within twelve months. He co-operated fully with Filton Technical College in commencing the first training scheme for hospital engineers in the country.

Mr. Williams vigorously supported the work of the Institute and particularly of the West of England Branch.

Mr. K. Law has been appointed Hospital Engineer to the Wellingborough Sub-Group. He comes into the Service from industry.

Mr. H. Moffat has been appointed Group Engineer to Derby No. 1 H.M.C. He also comes into the Service from industry.

Mr. A. Waters has been appointed Group Engineer to Little Plumstead H.M.C., and was previously Hospital Engineer at St. Audry's Hospital, Woodbridge.

WYTHENSHAWE KITCHEN CONTRACT

The Manchester Office of Moorwood-Vulcan Ltd. of Sheffield has been successful in obtaining an order valued at £24,000 for new kitchen equipment at Wythenshawe Hospital, Manchester.

The Consulting Engineers are Ernest Griffiths & Son, Bromborough; Mechanical and Electrical Contractors, Richard Crittall and Z. D. Berry of Liverpool.

NEW HOSPITAL CONTRACT FOR MATTHEW HALL

Matthew Hall Mechanical Services Ltd. are to receive an order to the value of approximately £1 million for the installation of mechanical services to the new Devon and Exeter Hospital, to be constructed at Wonford, Exeter, for the South-Western Regional Hospital Board.

The hospital will comprise a main building on two floors, and a seven-storey tower block. The main building will contain an out-patients' department and operating theatre; pharmacy; physiotherapy and occupational therapy; accident and emergency departments with associated operating theatres; a main operating suite with 8 theatres and C.S.S.D.; X-ray diagnostic and radio therapy departments, and all hospital administration and teaching departments. An area laundry is also included on the site. The services for which Matthew Hall will be responsible include air conditioning, heating, hot and cold water, ventilation and medical gases.

Architects: Watkins Gray Group 1.

Consulting Engineers: Hoare, Lee & Partners.

Main Contractor: Higgs & Hill Ltd.

FULHAM HOSPITAL BOILERS

A 25,000 lb./hr. Ruston Thermax boiler is one of three recently delivered for the new £11m. Fulham Hospital. Of the other two, one has a similar output while the other is a 20,000 lb./hr. unit. All operate at 120 lb./sq. in.

Together, the three boilers will supply complete heating and process steam for the whole project. A 60-ton crane was used to unload the boilers.

The Heating Consultants are Donald Smith, Seymour and Rooley, Heating Contractors are Rosser and Russell, and the General Contractors are Higgs and Hill Ltd.

Index to Advertisers

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Classified Advertisements

SITUATIONS VACANT

QUEEN CHARLOTTE'S AND CHELSEA HOSPITALS

HOSPITAL ENGINEER

HOSPITAL ENGINEER required. Major building project due to begin shortly. The successful candidate should have the H.N.C. or equivalent and be accustomed to interpret drawings and specifications and to set out jobs for tradesmen. Consideration will be given to the appointment on an abated salary scale of an applicant without the stipulated qualifications. Salary £1,345 rising to £1,575 per annum plus London Weighting. Accommodation adjacent to Queen Charlotte's Maternity Hospital will be available within some months.

Applications to be sent to the House Governor, 339 Goldhawk Road, London, W.6 within two weeks of the appearance of this advertisement.

NUFFIELD ORTHOPAEDIC CENTRE, HEADINGTON, OXFORD

HOSPITAL ENGINEER required at this hospital. Applicants must have a thorough practical training in mechanical and electrical engineering with a sound knowledge of steam boiler plant.

One of the following qualifications, or an equivalent approved by the Minister of Health, is desirable:—

1. Higher National Certificate or Higher National Diploma in Mechanical Engineering with endorsements in Industrial Organisation and Management and Principles of Electricity or Electro-Technology, if this was not taken as a subject of the course; or
2. Higher National Certificate or Higher National Diploma in Electrical Engineering with endorsements in Industrial Organisation and Management and including (at S.III or O2 level, or with endorsement in) Applied Heat and Applied Mechanics, provided he has suitable practical experience in mechanical engineering; or
3. City and Guilds Mechanical Engineering Technicians Full Technological Certificate (Part III) which must include Plant Maintenance and Works Service.

Salary £1,270 rising to £1,500, plus £50 responsibility allowance.

Further particulars can be obtained by telephone to the Group Engineer, Oxford 64811.

Applications, giving full particulars, including age, experience, qualifications and names and addresses of two referees to be sent to the Secretary by 30th November, 1968.

WINCHESTER GROUP H.M.C.
WINCHFIELD HOSPITAL, NR. BASINGSTOKE

ASSISTANT ENGINEER required at the above hospital. The post provides excellent experience for a young Engineer wishing to make advancement in hospital engineering. Day release facilities given for further study. Applicants should preferably possess Ordinary National Certificate in Engineering or equivalent. Salary scale: £975-£1,270 p.a. Abated scale for suitable candidates not in possession of these qualifications. Residential accommodation may be available. Applications, with names of three referees, to Group Secretary, Royal Hampshire County Hospital, Winchester by 22nd November, quoting Ref. HE121.

MOORHAVEN HOSPITAL MANAGEMENT COMMITTEE

GROUP ENGINEER required for psychiatric hospital group of 764 beds. Salary scale (12½ to 24 points) £1,550 to £1,805 per annum for qualified staff, plus responsibility allowance of £50. Additional gratuity paid as appropriate for hours worked over 45 per week.

The main boiler plant has just been converted to oil firing. Applicants must have had wide experience in the management of mechanical and electrical engineering plant similar to that of modern hospitals, and should hold the following qualifications:—

(i) Higher National Certificate or Higher National Diploma in Mechanical Engineering with endorsements in Industrial Organisation and Management and Principles of Electricity or Electro-Technology, if this was not taken as a subject of the course; or

(ii) Higher National Certificate or Higher National Diploma in Electrical Engineering with endorsements in Industrial Organisation and Management and including (at S.III or O2 level, or with endorsement in) Applied Heat and Applied Mechanics, provided he has suitable practical experience in mechanical engineering; or

(iii) City and Guilds Mechanical Engineering Technicians Full Technological Certificate (Part III) which must include Plant Maintenance and Works Service.

The successful applicant will also be responsible for building maintenance work with a small direct labour building section.

Salary scales, conditions of service and qualifications will be in accordance with those laid down by the appropriate Whitley Council.

The successful applicant could be non-resident, but temporary accommodation may be made available.

Applications, stating age and full personal particulars, details of training, qualifications and experience, and names and addresses of three referees, to be sent to the Group Secretary, Moorhaven Hospital, Ivybridge, South Devon by 16th November, 1968.

The post will be vacant by 1st June, 1969, owing to retirement.

BOARD OF MANAGEMENT FOR THE ORKNEY HOSPITALS

Assistant Engineer required to assist the Group Engineer in the operation and maintenance of the engineering services of the Orkney Hospitals. Applicants must have completed an apprenticeship in mechanical or electrical engineering and must hold an Ordinary National Certificate in Engineering or equivalent approved qualification.

Salary £975-£1,270. Apply in writing, before 18th November, 1968, stating age and experience and giving the names of two referees to the Group Secretary & Treasurer, Balfour Hospital, KIRKWALL, Orkney.

SOUTH WEST MIDDLESEX HOSPITAL MANAGEMENT COMMITTEE

HOSPITAL ENGINEER

required at

West Middlesex Hospital, Isleworth

Consideration will be given to applicants not possessing stipulated qualifications. Salary scale for points range "24½ and over"—£1,370-£1,605 p.a. plus £100 p.a. special responsibility allowance, plus £90 p.a. London Weighting. Salary will be abated by £200 p.a. if not possessing recognised qualifications.

West Middlesex Hospital (964 bedded general hospital) has a modern boiler house with fully automatic oil-fired boilers and a new 236 bedded Medical Department ('race track' design with full air-conditioning). This post offers exceptional variety of experience to Engineers who are keen to progress to the higher posts in the Health Service.

Application forms, together with further particulars, obtainable from and returnable to the Group Secretary, South West Middlesex Hospital Management Committee, West Middlesex Hospital, Isleworth, Middlesex, by 2nd December, 1968.

DONCASTER HOSPITAL MANAGEMENT COMMITTEE

DEPUTY GROUP ENGINEER

Salary scale £1,370 x 5 inc. to £1,605 p.a. plus £100 p.a. special responsibility allowance.

The person appointed will be required to act for the Group Engineer over the whole range of his duties.

In accordance with H.M. (68) 14, applicants must have completed apprenticeship in electrical engineering and have acquired thorough practical training as appropriate to duties and responsibilities of post. Must have wide experience in the management of mechanical and electrical plant, particularly on a planned basis. Experience must include control of maintenance staff, also preparation of maintenance estimates, specifications and drawings.

Applicants must hold following qualifications or approved equivalent:

H.N.C. or H.N.D. in Electrical Engineering with endorsements in Industrial Organisation and Management and including (at S3 or O2 level, or with endorsement in) Applied Heat and Applied Mechanics, provided he has the necessary practical experience in Mechanical Engineering.

Temporary rented accommodation will be available to successful applicant.

Full job description on request.

Applications stating qualifications, age and experience with names and addresses of two referees (one technical) to Group Secretary, Doncaster Royal Infirmary, Doncaster within 7 days of publication of this advertisement.

WELSH HOSPITAL BOARD

GROUP ENGINEER

required for a new Group of twenty-one hospitals. The successful candidate will be responsible for the engineering services of all the hospitals administered by the Management Committee and may ultimately also be responsible for the engineering services of an Area Laundry and C.S.S.D.

Salary £2,050—£2,430 plus special responsibility allowances.

New entrants to the Service commence at the minimum of the scale.

The successful applicant will be expected to take up duty on April 1st, 1969.

Applicants must have had wide experience in the management of mechanical and electrical engineering plant and must hold the H.N.C. or H.N.D. in Mechanical or Electrical Engineering with endorsements or the City and Guilds Mechanical Engineering Technicians Full Technological Certificate (Part III) which must include Plant Maintenance and Works Service or an equivalent qualification approved by the Minister of Health.

Application forms (for which a self-addressed foolscap envelope should be sent) to the Secretary, H.E., Welsh Hospital Board, Temple of Peace and Health, Cathays Park, Cardiff within 14 days of appearance of advertisement.

Further particulars can be obtained from the Secretary.

CARDIFF HOSPITAL MANAGEMENT COMMITTEE

Applications are invited for the appointment of HOSPITAL ENGINEER at the Prince of Wales Orthopaedic Hospital, Rhydlafar, Nr. Cardiff. Applicants must have served an apprenticeship in mechanical or electrical engineering, and have experience in management of engineering services, preferably in the hospital service. H.N.C. or Diploma in Mechanical or Electrical Engineering with specified endorsements essential. Salary scale £1,270—£1,500 p.a. plus £25 for special responsibilities. Bungalow available on site. Application form from Acting Group Secretary, Cardiff H.M.C., 44 Cathedral Road, Cardiff.

SUFFOLK MENTAL HOSPITALS MANAGEMENT COMMITTEE

HOSPITAL ENGINEER

ST. AUDRY'S HOSPITAL, MELTON, WOODBRIDGE, SUFFOLK

Applications are invited for this post from Engineers, qualified in accordance with Ministry of Health Regulations.

Salary Scale: £1,270 to £1,500 per annum plus £75 Special Responsibility Allowance.

Application forms and further details may be obtained from the Secretary, St. Audry's Hospital, Melton, Woodbridge, Suffolk.

Closing date for applications is November 22nd, 1968.

LEEDS (A) GROUP HOSPITAL MANAGEMENT COMMITTEE

DEPUTY GROUP ENGINEER

to act as Hospital Engineer at St. James's Hospital, Leeds (1,358 beds) and to be responsible to the Group Engineer, who is also based at the hospital. This is an attractive post as the hospital is going through a major redevelopment by the addition of modern buildings and associated engineering services. There is a wide range of plant and equipment and a system of planned preventive maintenance is being used on all new work. Experience in management of mechanical and electrical engineering plant and control and deployment of staff, required. Candidates with a recognised apprenticeship in mechanical or electrical engineering, and holding one of the following or equivalent qualifications preferred, although other applicants will be considered:—

H.N.C. or H.N.D. in Mechanical Engineering with endorsements in Industrial Organisation and Management and Principles of Electricity or Electro-Technology, if not a subject of the course.

H.N.C. or H.N.D. in Electrical Engineering with endorsements in Industrial Organisation and Management, including Applied Heat and Applied Mechanics, provided he has suitable practical experience in mechanical engineering.

Salary Scale £1,370-£1,605—i.e. Hospital Engineer 24½ points and over—plus £175 for special responsibility units as applies to the Group Engineer.

Applications, stating age, qualifications, experience, and names of two referees, to Group Secretary, Leeds (A) Group H.M.C., St. James's Hospital, Leeds, 9.

NEW SOUTHGATE GROUP HOSPITAL MANAGEMENT COMMITTEE

2,300 beds—Psychiatric

ASSISTANT ENGINEER (MECHANICAL) required in the Engineering Department of this Group. Successful applicant will be responsible to the Group Engineer for operation of mechanical services and boiler plant in the Group. Applicants must possess one of the following qualifications: (a) O.N.C. Mechanical Engineering; (b) Ministry of Transport Certificate of Competency Second Class if it includes an O.N.C. or O.N.D. Increments will be given for certain qualifications. Salary scale £975 rising to £1,270 per annum, plus London Weighting. Applications, in writing, to the Group Secretary, Friern Hospital, New Southgate, N.11.

SOUTH WEST MIDDLESEX HOSPITAL MANAGEMENT COMMITTEE

ASSISTANT ENGINEER

required at

West Middlesex Hospital, Isleworth.

Salary scale £975-£1,270 p.a. plus £90 p.a. London Weighting.

West Middlesex Hospital (946 bedded general hospital) has a modern boiler house with fully automatic oil-fired boilers and a new 236 bedded Medical Department ('race-track' design with full air-conditioning). This post offers exceptional variety of experience to Engineers who are keen to progress to the higher posts in the Health Service.

Application forms, together with further particulars, obtainable from and returnable to the Group Secretary, South West Middlesex Hospital Management Committee, West Middlesex Hospital, Isleworth, Middlesex, by 2nd December, 1968.

SOUTHEND-on-SEA HOSPITAL MANAGEMENT COMMITTEE

General Hospital, Rochford, Essex.

Applications are invited for the post of Hospital Engineer to be responsible to the Group Engineer for the services at Rochford General Hospital, Rochford, Essex.

Applicants must have completed an apprenticeship in mechanical or electrical engineering, or have otherwise a thorough practical training as appropriate to the duties and responsibilities of the post.

Applicants must be suitably qualified in accordance with the terms of P.T.B. circular 191 (details may be obtained on enquiry). Salary scale £1,370-£1,605 plus a special responsibility allowance of £50. Additional gratuity payable (max. 10 per cent of salary) for hours worked over and above 38 per week.

Applications stating age, qualifications and experience, together with the names of three referees, to be sent to the Group Secretary, Rochford General Hopital, Rochford, Essex by 15th November.

TOTTENHAM GROUP HOSPITAL MANAGEMENT COMMITTEE

Applications are invited for the post of HOSPITAL ENGINEER for The Prince of Wales's General Hospital, N.15, and other associated units.

Salary scale £1,385-£1,615. Extra Duty Allowance up to 10 per cent, Less £150 p.a. if unqualified.

Application form and further particulars sheet obtainable from the Group Secretary, Tottenham Group Hospital Management Committee, The Green, Tottenham, N.15.

SITE INSPECTORATE

St. Thomas' Hospital, London, S.E.1.

The second stage of the reconstruction of the Hospital, costing approximately £13 million, will start in February 1969 and take about 5½ years to complete. Engineering services comprise approximately 40 per cent of the contract.

Applications are invited for the following posts:—

(a) **DEPUTY SITE ELECTRICAL ENGINEER** (one post) and

DEPUTY SITE MECHANICAL ENGINEER (one post)

Salary scale £1,900-£2,185 including London Weighting. Appointments will be made as soon as possible. Closing date for applications is the 29th November, 1968.

Applicants should have served an apprenticeship and hold the O.N.C. in Mechanical or Electrical Engineering and have had at least five years experience as a site supervisor for engineering services of large buildings.

(b) **SITE INSPECTOR** (Mechanical Engineering Services) (one post)

Salary scale £1,175-£1,565 including London Weighting. An appointment will be made as soon as possible after the 1st January, 1969. Closing date for applications is the 29th November, 1968.

Applicants should have served an apprenticeship and have had at least five years experience supervising mechanical engineering site installations.

Further details and application forms may be obtained from the Personnel Officer.

WEST SOMERSET GROUP HOSPITAL
MANAGEMENT COMMITTEE

Applications are invited for the post of **GROUP ENGINEER** *for the full range* of mechanical, electrical and engineering services and for building maintenance works.

The Group comprises twelve hospitals, mostly acute general hospitals, totalling 1,097 beds. The Group Headquarters, at which the Group Engineer is based, is at Musgrove Park Hospital, Taunton and considerable Capital Development is currently being planned at this hospital and the East Reach Hospital, Taunton.

The current salary scale for the post is £1,850 rising by annual increments to £2,180 per annum plus a special responsibility allowance of approximately £100. Car user expenses paid in accordance with approved scales.

The post will become vacant through the promotion of the present holder on the 1st December, 1968, and the person appointed will be expected to live within a reasonable distance of the main hospital. Removal expenses payable in accordance with regulations.

Applicants must have completed an apprenticeship or a thorough practical training, and must have wide experience in the management of mechanical and electrical engineering plant and in the control and employment of maintenance and operational staff.

They must also possess one of the following qualifications, or an equivalent qualification approved by the Ministry of Health or Secretary of State for Scotland:—

(a) Higher National Certificate or Higher National Diploma in Mechanical Engineering with endorsements in Industrial Organisation and Management and Principles of Electricity or Electro-Technology, if this was not taken as a subject of the course; or

(b) Higher National Certificate or Higher National Diploma in Electrical Engineering with endorsements in Industrial Organisation and Management and including (at S.III or O2 level, or with endorsement in) Applied Heat and Applied Mechanics, provided he has suitable practical experience in mechanical engineering.

Applicants not possessing one of the above qualifications will be considered but, if appointed, their salary scale will be abated.

Short listed applicants will be given every opportunity of seeing what the job entails and suitably qualified intending applicants can, by arrangement, visit the hospitals. Applicants seeking further information regarding the post are invited to write to the undermentioned, to whom applications should be submitted, giving full details of age, qualification and experience, and the names and addresses of three referees, within 10 days from the appearance of this advertisement.

R. F. LOVETT, Group Secretary.
Musgrove Park Hospital, Taunton, Somerset.

MISCELLANEOUS

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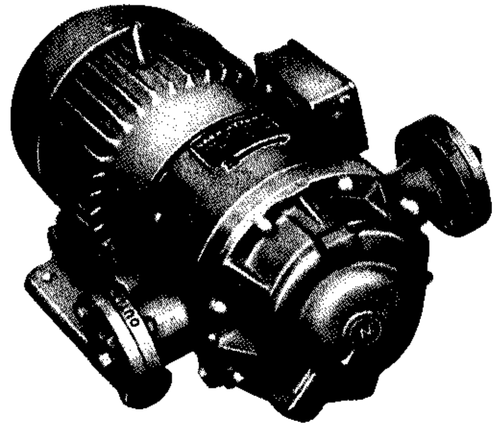

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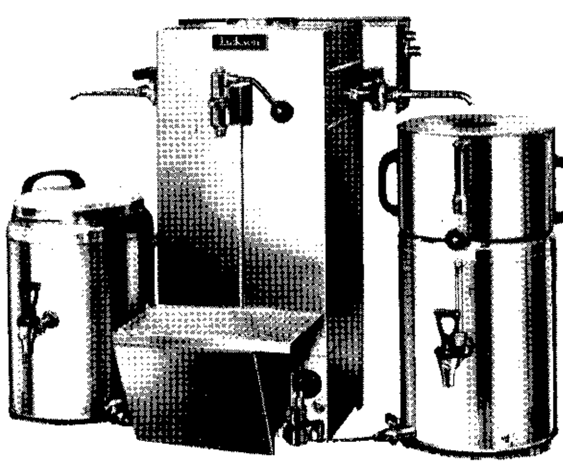

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Our brilliant new range of "square look" quick-service water boilers and counter sets – which have attracted so much attention — provide all the advantages of advanced functional design . . . more compact. SQUARE DEAL! Write for full details.

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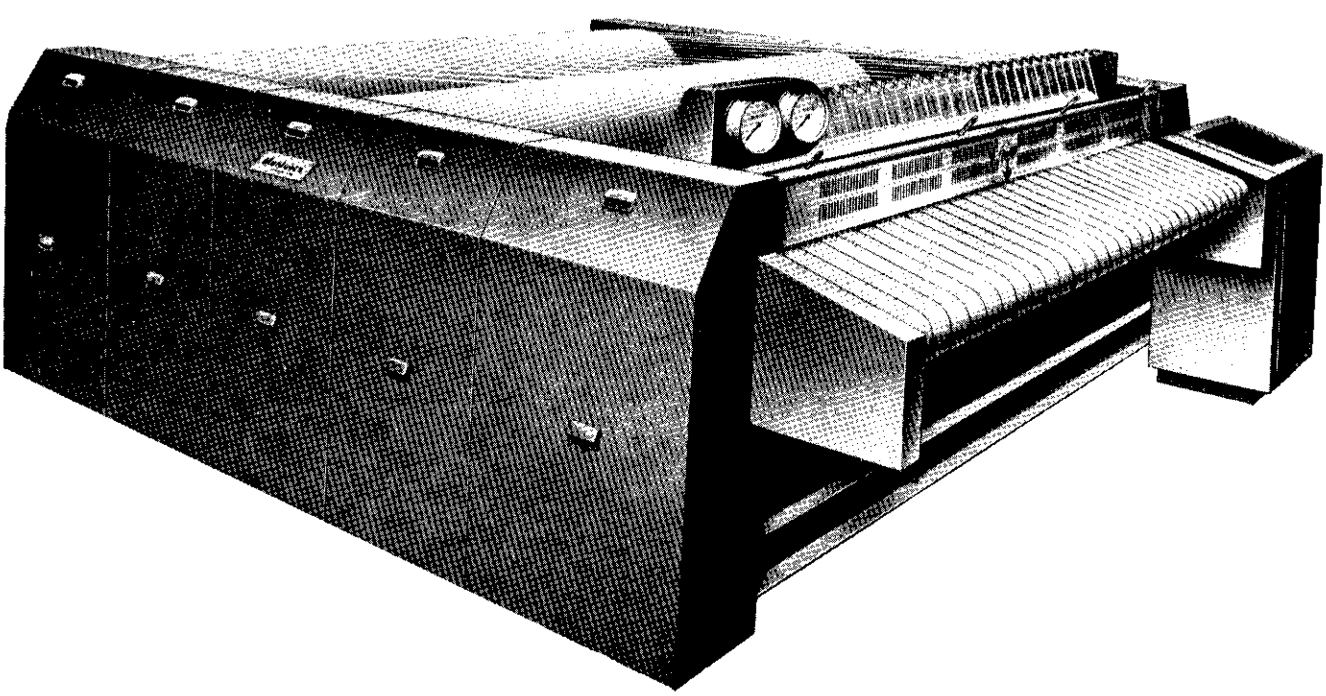

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